

CHAPTER 2

AIR TOXICS MONITORING AND ANALYSES

Air Toxics Monitoring and Analyses

2.1 Substances Monitored

The chemical compounds (Table 2-1) monitored in MATES V include the airborne toxics found in previous studies posing the most significant contributions to health risks in the Basin, along with other compounds used to help identify sources. Additional measurements for MATES V included field-based measurements of total carbon, organic carbon, and ammonia at the Central Los Angeles and Rubidoux sampling sites, as well as ions, and black carbon (BC) at all fixed monitoring sites. Measurements of levoglucosan, mannosan, and galactosan were added at all fixed monitoring sites, as these sugars, formed from the combustion of cellulose, are indicators of biomass burning (see Appendix XII). The substances listed below in Table 2-1 exclude those measured in MATES V Refinery monitoring projects.

Table 0-1 Substances Monitored in MATES V

Pollutant Category		Measured Pollutants
Ultrafine Particles (UFPs)		UFPs
PM_{2.5}	Ions	Ammonium Ion, Chloride, Nitrate, Potassium Ion, Sodium, Sulfate
	Sugars	Galactosan, Levoglucosan, Mannosan
	Metals	Aluminum, Antimony, Arsenic, Barium, Cadmium, Calcium, Cesium, Chlorine, Chromium, Cobalt, Copper, Iron, Lead, Magnesium, Manganese, Molybdenum, Nickel, Phosphorus, Potassium, Rubidium, Samarium, Selenium, Silicon, Strontium, Sulfur, Thallium, Tin, Titanium, Uranium, Vanadium, Yttrium, Zinc
	Other	PM _{2.5} mass, Black Carbon (BC), Elemental Carbon (EC), Organic Carbon (OC), Total Carbon (TC)
Total Suspended Particulate (TSP)	Metals	Antimony, Arsenic, Barium, Beryllium, Cadmium, Calcium, Cesium, Chromium, Cobalt, Copper, Cr ⁶⁺ (hexavalent chromium), Iron, Lead, Manganese, Molybdenum, Nickel, Potassium, Rubidium, Selenium, Strontium, Tin, Titanium, Uranium, Vanadium, Zinc
Volatile Organic Compounds (VOCs)	Carbonyls	2-Butanone (Methyl Ethyl Ketone), Acetaldehyde, Acetone, Benzaldehyde, Formaldehyde, Propionaldehyde
	Other	1,2-Dibromoethane, 1,2-Dichlorobenzene, 1,2-Dichloroethane, 1,2-Dichloropropane, 1,3-Butadiene, 1,4-Dichlorobenzene, 2-Butanone (Methyl Ethyl Ketone), Acrolein (2-Propenal), Acetone, Benzene, Bromomethane, Carbon Tetrachloride, Chloroform,

		Ethylbenzene, m+p-Xylene, Methyl tert-Butyl Ether (MTBE), Methylene Chloride, o-Xylene, Styrene, Tetrachloroethylene (Perchloroethylene), Toluene, Trichloroethylene, Vinyl Chloride
Polycyclic Aromatic Hydrocarbons (PAHs)		9-Fluorenone, Acenaphthene, Acenaphthylene, Anthracene, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(e)pyrene, Benzo(g,h,i)perylene, Benzo(k)fluoranthene, Chrysene, Coronene, Cyclopenta(c,d)pyrene, Dibenz(a,h)anthracene, Fluoranthene, Fluorene, Indeno(1,2,3-c,d)pyrene, Naphthalene, Perylene, Phenanthrene, Pyrene, Retene

Since the toxic particulate bound components are all present within the PM_{2.5} and Total Suspended Particulate (TSP) size fractions, measurements of PM₁₀ were not included under MATES V.

2.2 Monitoring Sites

Seven of the ten monitoring sites operated for MATES V are identical to those used in the MATES IV Study. The location of three sites (Long Beach, Huntington Park, and Burbank) were moved because the previous locations used in MATES IV were not available. The distances between the MATES V sites and the corresponding MATES IV sites are listed below.

- Burbank MATES V site approximately 8 miles NE of MATES IV site;
- Long Beach MATES V site approximately 2.3 miles SE of MATES IV site;
- Huntington Park MATES V site approximately .9 miles East of MATES IV site.

The MATES sites were originally selected to measure numerous air toxic compounds at different locations in the Basin to establish representative baseline regional-scale data for ambient air toxic concentrations and associated health risks. These sites were also selected to assist in the assessment of modeling performance accuracy.

The locations for the 10 fixed sites reflect a representative distribution within the Basin and are geographically dispersed, and generally selected to be residential or commercial areas in order to reflect air toxics exposures to the general public. Fixed site locations include areas that vary in land-use types, including areas that are closer to industrial and/or commercial sources of air toxics and areas that are primarily residential neighborhoods. The sites also reflect resource constraints and the leveraging of existing monitoring programs and the availability of specialized equipment. The sites used in MATES V are shown in Figure 2-1. Changes in station locations from MATES II through V are shown in Figure 2-2.

The 10 sites were originally selected with the input from the MATES II Technical Review Group and the Environmental Justice Task Force as well as with review from the MATES V technical advisory group; precise locations for MATES V stations are listed in Table 0-2. Appendix IV

contains a table of the latitude and longitude for each MATES II through V station. The Central L.A. and Rubidoux sites were selected to provide continuity with CARB long-term trend sites. The Inland Valley San Bernardino, Long Beach, and Burbank sites were selected to provide geographic continuity with previous MATES studies. The Pico Rivera site was selected to leverage existing monitoring resources available from the U.S. EPA-sponsored PAMS Program which has provided well-characterized air monitoring data from this site since 2005. Anaheim was chosen for geographic equity, such that there was at least one site in each of the four counties. West Long Beach, Compton, and Huntington Park sites were selected to examine environmental justice concerns. Because the fixed-site locations are based on U.S. EPA guidelines for “neighborhood scale” monitoring, each of these sites may also be representative of adjacent communities. At each site, sampling equipment included particulate, VOC canister, and carbonyl samplers, as well as equipment for continuous measurement of black carbon, PM number concentration, and relevant meteorological parameters.

Table 0-2 MATES V Site Locations

Site	Address
Anaheim	1630 W. Pampas Ln., Anaheim, CA 92802
Burbank Area	Airpark Way, Pacoima, CA 91331 (0.5 miles NW of Osborne St.)
Compton	720 N. Bullis Rd., Compton, CA 90221
Inland Valley San Bernardino	14360 Arrow Route, Fontana, CA 92335
Huntington Park	2975 Zoe Ave., Huntington Park, CA 90255
Long Beach	1710 E. 20 th St., Signal Hill 90755
Central Los Angeles	1630 N. Main St., Los Angeles, CA 90012
Pico Rivera	4144 San Gabriel River Pkwy., Pico Rivera, CA 90660
Rubidoux	5888 Mission Blvd., Riverside, CA 92509
West Long Beach	2425 Webster Ave., Long Beach, CA 90810

*Latitude and longitude of each station is shown in Appendix IV.



Figure 2-1. Location of MATES V Monitoring Locations.

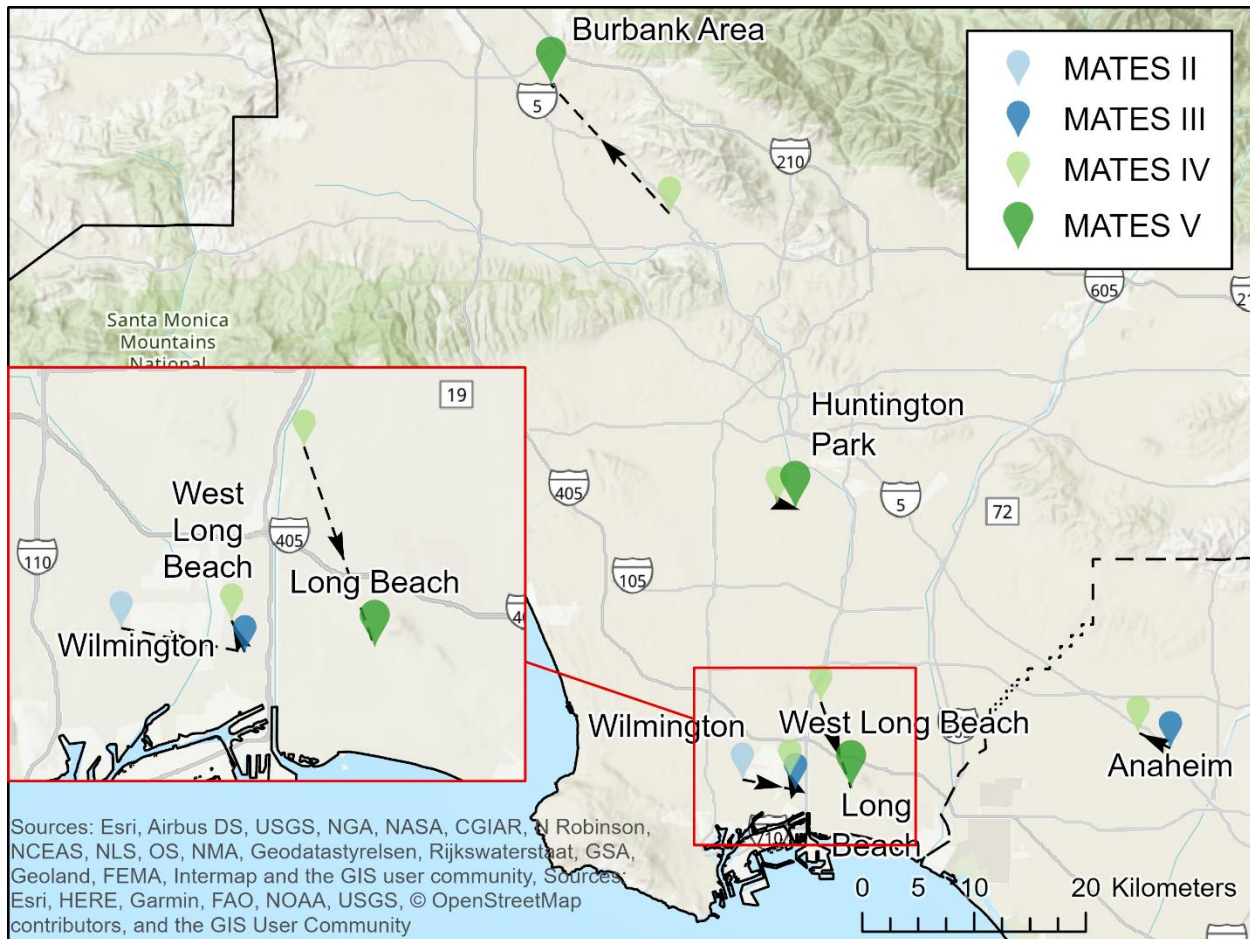


Figure 2-2 Changes in Monitoring Locations.

2.3 Advanced Air Monitoring Efforts

Part of MATES V used advanced air monitoring technologies to complement and enhance fixed site monitoring, provide higher resolution air quality data, estimate emissions from petroleum refineries and better characterize air toxics levels in highly impacted areas. To this end, staff worked with contractors specializing in optical remote sensing and other state-of-the-art air monitoring methods to fully characterize refinery emissions and their potential impact on local communities. Flight-based measurements provided air toxics data across a large portion of the Basin where major refineries are located. This data helped guide selection of target areas for ground-level mobile monitoring and sensor deployments. Ground-level mobile monitoring allowed for VOC measurements at all major refineries in the South Coast AQMD. An “optical-tent” was developed and deployed at one of these refineries for long-term near-real time monitoring of benzene, toluene, and xylene (BTX) and to help identify leaks. A PM sensor network was deployed in one EJ community located near a major refinery to explore the capabilities of this emerging technology to complement existing ground-based measurements. Information from the various advanced technologies and project components complemented each other. Overall, the results of these advanced refinery measurements will provide unique

information to inform community stakeholders about the air quality in these neighborhoods. The results of this advanced air monitoring portion of MATES V will be summarized and discussed in detail in a separate report.

In addition to the 10 fixed sites and the monitoring methods described above, mobile monitoring platforms focused on local scale studies at several locations for short durations were deployed. A unique set of rapidly deployable mobile air toxics monitoring platforms using the latest available technologies for continuous measurements were used. This was an important MATES V enhancement as continuous data, combined with continuous meteorological measurements, is extremely valuable in determining potential source locations and air pollutant variability.

Each of these platforms were equipped with a DustTrak DRX (TSI, Inc.); an instrument that continuously measures mass concentrations of different size fractions of PM. UFP measurements were achieved with a Condensation Particle Counter (CPC, model 3781; TSI, Inc.), which monitors the particle number concentrations down to 6 nm in size and up to concentrations of 500,000 particles per cubic centimeter ($\#/cm^3$). A portable Aethalometer (AE22; Magee, Inc.) for real-time measurements of BC was also installed as an indicator of DPM.

The mobile monitoring efforts and results are summarized in Chapter 5.

2.4 Ambient Sampling Schedule

The MATES V project conducted air toxics monitoring at 10 locations over a one-year period beginning May 1, 2018 and ending April 30, 2019. Previous MATES monitoring dates are as follows: April 1998-March 1999 for MATES II, April 2004-March 2006 for MATES III, and July 2012-June 2013 for MATES IV. Sampling for MATES V followed a one-in-six day, 24-hour integrated-sampling schedule, identical to the U.S EPA federal programs sampling schedule. This type of sampling schedule is designed to provide a dataset that is representative of the overall levels in the area over the course of the year, including capturing day-of-week variations. Black carbon (BC) and ultrafine particles (UFP, particles smaller than 0.1 μm in size) were measured in addition to the air toxics. These measurements were conducted with continuous sampling methods as described below.

2.5 Monitoring and Laboratory Analysis

For MATES V, meteorological equipment and sampling equipment for canisters, TSP and PM_{2.5} filters, and carbonyl cartridges from the existing air monitoring network were used to the greatest extent possible. The South Coast AQMD laboratory provided analytical equipment and conducted analysis. The analytical methods used to measure ambient species are briefly described below and in Table 0-3. Detailed protocols are described in Appendix III.

Table 0-3 Sampling and Analysis Methods for MATES V

Species	Sampling	Laboratory Analysis
Ions in Particulate Matter	PM Filters	Water extracts were analyzed by ion chromatography (IC) with conductivity detection
Sugars (Levoglucosan,	PM Filters	Acetonitrile extracts were derivatized and then analyzed by gas chromatography – mass spectrometer (GC-MS)

Mannosan, Galactosan)		
TSP Metals	Cellulose Fiber Filters	Nitric acid extracts were analyzed by inductively coupled plasma mass spectrometry (ICP-MS)
PM2.5 Metals	PM Filters	Filters were analyzed by energy dispersive x-ray fluorescence spectrometry (XRF)
Hexavalent Chromium	Cellulose Fiber Filters	Bicarbonate extracts were analyzed via ion chromatograph (IC) equipped with post-column derivatization, and UV-visible spectroscopic detection
Elemental and Organic Carbon	PM Filters	Section of PM filter removed and analyzed on a laser corrected carbon analyzer
Carbonyls	DNPH Cartridge	Acetonitrile recovery and subsequent analysis via high performance liquid chromatography (HPLC) or ultra high performance liquid chromatography (UHPLC) with UV-visible spectroscopic detection
Volatile Organic Compounds (VOCs)	Silica-Lined Canisters	Canisters analyzed by gas chromatograph – mass spectrometer (GC-MS) with automated pre-concentration and cryo-focusing
Black Carbon	Continuous	Aethalometer
UFP	Continuous	Condensation Particle Counters (CPC)

Volatile Organic Compounds

Volatile organic compounds (VOCs) were measured from air samples collected in silica-lined canisters. VOCs were identified and quantified using pre-concentration and a gas chromatograph mass spectrometer (GC-MS) under the U.S. EPA TO-15 method.

Carbonyl Compounds

Carbonyl compounds were sampled by drawing air continuously through DNPH (2,4-Dinitrophenylhydrazine) impregnated cartridges. The carbonyl compounds undergo derivatization with DNPH, and the derivatives were extracted in acetonitrile and analyzed using high performance liquid chromatography (HPLC) or ultra high performance liquid chromatography (UHPLC) with UV-visible spectroscopic detection in accordance with U.S. EPA Method TO-11.

PAHS

Naphthalene and other polycyclic aromatic hydrocarbons (PAHs), components of both mobile source and stationary source emissions, were measured at two of the monitoring stations: Central Los Angeles and Rubidoux. Sample media were provided by the Eastern Research Group (ERG) and assembled into sampling cartridges by South Coast AQMD laboratory staff. Samples were collected by South Coast AQMD field staff and analyzed under the EPA NATTS Program by ERG after sampling cartridge deconstruction by South Coast AQMD laboratory staff. The Central Los Angeles and Rubidoux sites are part of the NATTS network.

Hexavalent Chromium

Hexavalent chromium (Chrome VI) was quantitated using ion chromatography (IC), post-column derivatization, and UV-visible spectroscopic detection. The filters are pre-treated with

sodium bicarbonate to prevent conversion of Chrome VI to Chrome III. Chrome VI is extracted from the filter in sodium bicarbonate by sonication and subsequently analyzed using IC.

Particulate Matter

Total suspended particulates (TSP) and particulates less than 2.5 microns (PM_{2.5}) were collected separately over a 24-hour period using size selective inlets according to U.S. EPA's Federal Reference Methods (40CFR50).

Metals in Total Suspended Particulate (TSP) samples were extracted using nitric acid and the extracts were measured using ICP-MS. Metals in PM_{2.5} samples were determined by a non-destructive method, Energy Dispersive X-Ray Fluorescence Spectrometry. Identification of ions within the PM samples was performed by water extraction and analysis using Ion Chromatography with a conductivity detector.

Carbon analysis for Elemental Carbon (EC) and Organic Carbon (OC) was conducted by taking a small circular disk from sampled PM_{2.5} filters. The circular disk was placed into a carbon analyzer which utilizes a thermal optical transmittance method (IMPROVE A method) to measure the OC and EC content of the filter.

Particulate Sugars (Levoglucosan, Mannosan, Galactosan)

PM_{2.5} quartz filters are extracted in acetonitrile using sonication. The extracts are then derivatized and then analyzed using GC-MS. The method is further discussed in Appendix XII.

BC and UFP

BC measurements were carried out using Aethalometers. This instrument uses the light-absorbing properties of BC which is related to the particulate BC mass concentration.

UFP number concentration data were collected continuously (i.e. one-min. time resolution) using water-based Condensation Particle Counters. This instrument provides the total number concentration of particles above 7 nm in real-time.

Additional details of the methods are in Appendix VI.

Results for the BC and UFP monitoring are summarized in Chapter 5.

Diesel Particulate Matter

It is not possible to measure diesel exhaust directly from ambient concentrations. However, one can use elemental carbon (EC) concentrations to estimate diesel exhaust concentrations. Since there are other non-diesel sources of EC, the ratio of EC to diesel concentrations are estimated from emissions or modeled concentration data. For MATES II and III, a single ratio representing the entire Basin for each study was calculated from emissions data; these methods are detailed in previous MATES reports. For MATES V, the ratio of modeled EC concentrations and modeled diesel PM concentrations was determined at each monitoring station. This ratio was then used to estimate the concentration of diesel exhaust from the measured EC concentrations at each station. To provide a consistent comparison, the same method was applied to the MATES IV data presented in this report. However, due to limited availability of modeling data, this method

could not be applied to MATES II and III data. Table 2-4 shows the multiplication factors used to estimate diesel exhaust.

Table 0-4. Multiplication Factors for Estimating Diesel Exhaust Concentrations.

MATES Project	Station	EC Multiply Factor	Diesel Surrogate
MATES II	All	1.04	PM ₁₀ Elemental Carbon
MATES III	All	1.95	PM _{2.5} Elemental Carbon
MATES IV	Anaheim	0.8066	PM _{2.5} Elemental Carbon
MATES IV	Burbank Area	0.8722	PM _{2.5} Elemental Carbon
MATES IV	Central L.A.	0.8929	PM _{2.5} Elemental Carbon
MATES IV	Compton	0.8261	PM _{2.5} Elemental Carbon
MATES IV	Huntington Park	0.7592	PM _{2.5} Elemental Carbon
MATES IV	Inland Valley San Bernardino	0.7803	PM _{2.5} Elemental Carbon
MATES IV	Long Beach	0.7885	PM _{2.5} Elemental Carbon
MATES IV	Pico Rivera	0.8356	PM _{2.5} Elemental Carbon
MATES IV	Rubidoux	0.9397	PM _{2.5} Elemental Carbon
MATES IV	West Long Beach	0.805	PM _{2.5} Elemental Carbon
MATES V	Anaheim	0.7126	PM _{2.5} Elemental Carbon
MATES V	Burbank Area	0.7542	PM _{2.5} Elemental Carbon
MATES V	Central L.A.	0.7719	PM _{2.5} Elemental Carbon
MATES V	Compton	0.7053	PM _{2.5} Elemental Carbon
MATES V	Huntington Park	0.7347	PM _{2.5} Elemental Carbon
MATES V	Inland Valley San Bernardino	0.7702	PM _{2.5} Elemental Carbon
MATES V	Long Beach	0.7037	PM _{2.5} Elemental Carbon
MATES V	Pico Rivera	0.7167	PM _{2.5} Elemental Carbon
MATES V	Rubidoux	0.8658	PM _{2.5} Elemental Carbon
MATES V	West Long Beach	0.8332	PM _{2.5} Elemental Carbon

2.6 Quality Assurance and Quality Control

South Coast AQMD is committed to achieving high quality data of a known and defensible quality that meets the objectives for the MATES program, as well as other air monitoring programs. MATES V adopts a combination of existing quality assurance plans and activities from ongoing programs that provide comparability and consistency with MATES V goals. The South Coast AQMD is designated by U.S. EPA as a Primary Quality Assurance Organizations (PQAO) with primary responsibility for ambient air monitoring and program satisfying data

quality under its jurisdiction. The agency's Quality Management Plan (QMP¹), approved by U.S. EPA in 2017, is the foundational document describing the agency's quality management system for air monitoring and laboratory analyses.

Quality Assurance (QA) encompasses all measures taken by management and staff to ensure that the quality of the finished product meets regulations, programmatic needs and the standards of the organization appropriate for the goals of the air measurement project. Major QA functions include review and oversight of program planning documents, records and procedures, as well as independent assessments of sampling procedures and instruments as well as performance testing of laboratory analyses. Quality Control (QC) encompasses the direct actions taken to achieve and maintain a desired level of quality including all the routine checks, maintenance and calibration verifications taken to achieve data reliability and measurement uncertainty.

Quality Assurance Project Plans (QAPPs) describe the required QA and QC steps and responsible entities, as well as plans for training, records management, and other related technical activities for the monitoring project or program. QAPPs incorporate Standard Operating Procedures (SOPs), which are specific directions for performing monitoring operations, support (maintenance, repairs, calibrations), lab analyses, and independent data quality assessment activities. The QAPP documents and summarizes plans for data review and validation, QA oversight, and the corrective action process that is used to document issues that may have significant or repeated impacts to data quality, completeness or safety, including the issue's resolution and steps to minimize recurrence.

The gaseous and particulate pollutant measurements for MATES V are based on comparable measurements from ongoing federal and agency programs and use the same quality goals, QA/QC activities, and procedures described in South Coast AQMD QAPPs, as outlined below.

National Air Toxics Trends Stations (NATTS) Program

The MATES V quality goals and QA/QC activities for sampling and analyzing ambient levels of VOCs, carbonyls, hexavalent chromium, PAHs, and some metals were adopted from the U.S. EPA NATTS program. The South Coast AQMD NATTS QAPP was last revised in 2013 and is under revision to incorporate new elements in the October 2016 U.S. EPA revised NATTS Technical Assistance Document (TAD) and other recent changes to the program that have been implemented by South Coast AQMD.

Chemical Speciation Network Program (CSN)

The MATES V quality goals and QA/QC activities for monitoring and analyzing the components of fine particulate matter with diameters that are 2.5 micrometers and smaller (PM_{2.5}), including Organic and Elemental Carbon (OC/EC), Anions, Cations, and trace metals, were adopted from the U.S. EPA CSN program. The requirements can be found in the South Coast AQMD PM_{2.5} Chemical Speciation Program QAPP, which was approved by U.S. EPA Region 9 in May 2014. This QAPP is also undergoing revision by staff to more fully incorporate both the U.S. EPA CSN Program process, where analyses are done by national contract laboratories, and changes in

¹ The South Coast AQMD Quality Management Plan, Quality Assurance Project Plans (QAPPs) and related Standard Operating Procedures (SOPs) are available upon request through the South Coast AQMD Monitoring and Analysis Division, Quality Assurance Branch.

the South Coast AQMD supplemental chemical speciation program, where analyses are done by the South Coast AQMD laboratory (as done for MATES).

Criteria Pollutant Monitoring Program

The MATES V quality goals and QA/QC activities for monitoring and analyzing TSP-Lead (Pb) and PM_{2.5} fine inhalable particle mass were adopted from the U.S. EPA Criteria Pollutant Monitoring Program. These goals and requirements can be found in the South Coast AQMD Criteria Pollutant Monitoring Program QAPP, which, at the time of the MATES V monitoring, was last revised in 2016. This QAPP was recently revised again in April 2020 to incorporate new program elements and guidance, including that contained in the updated U.S. EPA Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. II, Ambient Air Quality Monitoring Program (January 2017). This latest QAPP revision was approved by U.S. EPA Region 9 in July 2020.

Special Monitoring Programs

The South Coast AQMD Special Monitoring program provides air quality measurements in response to events such as wildfires, localized air quality concerns in communities, and pollutants from local sources, including rule compliance monitoring and rule development activities. The MATES V quality goals and QA/QC activities for monitoring and analyzing ultrafine particles (UFPs) and black carbon (BC) can be found in the South Coast AQMD Special Monitoring Program QAPP. It also describes the standardized practices and procedures followed by South Coast AQMD for monitoring other "non-criteria" pollutants and performing local-scale or facility focused measurement studies. The current version of this QAPP was last revised in 2013. This Special Monitoring QAPP is undergoing revision as a component of a new Special Monitoring and AB 617 Community Air Monitoring Programs QAPP.

2.7 MATES V Sampling Issues

Sampling manifold issues occurred during a portion of the May 2018 through April 2019 MATES V sampling period for VOC canister and carbonyl samples for three monitoring stations (Central Los Angeles, Rubidoux and Anaheim).² This was discovered during the South Coast AQMD Laboratory analysis and data validation process near the end of MATES V as staff identified anomalous carbonyls as compared to historic data. Lab staff informed the Quality Assurance Branch about the anomalous data with a Quality Assurance Alert (QAA), starting a corrective action process and the issuance of a Corrective Action Request (CAR) to trigger further investigation, evaluation, a data treatment plan, and corrective actions to resolve the issue and minimize the potential for future recurrence. Manifold flow testing at all ten MATES V stations, confirmed only minor leaks from loose manifold fittings at Rubidoux and Central Los Angeles and a more severe leak from a missing ferule on the manifold inlet at Anaheim. The leakage was especially indicated by unusually high formaldehyde and acetaldehyde concentrations associated with emissions from station building materials, such as flooring and wallboard. Since the leaks were associated with loose or missing fittings and not from completely disconnected sampling lines, the sampled air was still assessed to be predominantly

² Note that this sampling manifold issue also impacted other program samples on the same manifold at Central Los Angeles and Rubidoux, as follows: VOC and carbonyl sampling data for NATTS (same as MATES-V samples), PAMS, and CARB Air Toxics Program (VOC canister samples only).

ambient outdoor air. To further assess the impact of indoor air leakage on compounds of interest, staff conducted indoor/outdoor concurrent VOC canister and carbonyl sampling at each location. These samples were analyzed to identify potential for the leaks to bias data, by analyte.

Table 2-4 shows the time period of the manifold leaks at each station, along with the percentage of the MATES V period data invalidated. Due to the presence of significant outliers, all carbonyl data was invalidated during the leak period for all three stations. The invalidated analyte data was removed from the database and replaced with a null code (AQS Null Code BJ, Operator Error). When compared to historical data, the MATES VOC canister samples for Central Los Angeles and Rubidoux did not indicate outliers for those analytes; therefore, no results were invalidated. However, the data was flagged with a qualifier code (AQS Qualifier Code 3, Field Issue) to warn data users of potential data issues that could appear during data analysis. Due to the more severe magnitude of the manifold leak at Anaheim, all VOC data from this site was invalidated during the leak period.

Table 0-4. Manifold Leak Periods and Percentages of VOC and Carbonyl Data Invalidated by Site during the 1-Year MATES V Sampling Period

	Rubidoux	Central Los Angeles	Anaheim
MATES V Sampling Period (1 Year): 5/1/2018 – 4/30/2019			
MATES V Manifold Leak Period	5/1/2018 – 2 /19/2019	8/18/2018 – 4/25/2019	5/1/2018 – 4/30/2019
Percent of Invalidated VOC Samples	0% (0 of 61 samples)	0% (0 of 61 samples)	100% (61 of 61 samples)
Percent of Invalidated Carbonyl Samples	80%* (49 of 61 samples)	69% (42 of 61 samples)	100% (61 of 61 samples)

* includes 2 Rubidoux carbonyl samples that invalidated due to other sampler run issues

2.8 Air Toxics Cancer Risk Estimates

Air toxic cancer risks are estimated using the risk assessment methodologies defined in the OEHHA Air Toxics Hot Spots Program Risk Assessment Guidelines (March 2015)³. Although there are inherent uncertainties in risk assessment, as discussed in Chapter 1, risk assessment remains the most useful tool to estimate the potential health risks due to low level environmental toxics exposures. This risk assessment tool is also useful as a yardstick to measure progress

³ California Environmental Protection Agency Office of Environmental Health Hazard Assessment, Air Toxics Hot Spots Program Risk Assessment Guidelines. The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments. August 2003.

towards improving air quality.

The MATES II and III reports relied on the 2003 OEHHA risk assessment guidance. In March 2015, OEHHA updated the methods for estimating cancer risks.⁴ The revised methodology includes utilizing age sensitivity factors to weigh early life exposure, higher as well as updated assumptions on breathing rates, and length of residential exposures. When combined together, staff estimates that risks for the same inhalation exposure level are about 2.5 times higher than using the 2003 OEHHA risk assessment methods.⁵ The MATES V analysis used the 2015 OEHHA guidance.

Two important updates were implemented for MATES V. First, previous MATES studies have calculated cancer risks from inhalation pathways only. MATES V estimates cancer risks resulting from both inhalation and non-inhalation pathways based on the 2015 OEHHA risk assessment guidance. Exposure from non-inhalation pathways result from substances that deposit on the ground in particulate form and contribute to risk through the ingestion of soil or homegrown crops, or through dermal absorption⁶. This methodology is consistent with how cancer risks are estimated in South Coast AQMD's programs such as permitting, Air Toxics Hot Spots (AB2588), and CEQA. Secondly, cancer risks from MATES II through IV have been re-examined using the 2015 OEHHA risk assessment guidance and modern statistical methods to provide a consistent comparison of cancer risk trends.

2.9 Chronic Non-Cancer Risk Estimates

Chronic non-cancer risks are long-term non-cancer health impacts from exposure to toxic air contaminants that have a defined Reference Exposure Levels (REL). A REL is defined as the concentration at which no adverse non-cancer health effects are anticipated for one or more target organ systems (reference: OEHHA Hot Spots, section 8.3). Similar to cancer risks, risks from both inhalation and non-inhalation pathways were calculated and reported for this study.

Procedure for calculating chronic non-cancer risk values at a measurement station

1. For each measured species:
 - a. Calculate the product of the annual average concentration and a multi-pathway factor that considers exposures in addition to inhalation (soil, dermal, mother's milk, and homegrown crops)
 - b. Calculate the multi-pathway hazard quotient by dividing the product from step 1a by the REL
 - c. Apply the multi-pathway hazard quotient to all applicable impacted target

⁴ California Environmental Protection Agency Office of Environmental Health Hazard Assessment, Air Toxics Hot Spots Program Risk Assessment Guidelines. The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments, February, 2014.

⁵ In the May 2015 Final MATES IV Report, the increased in risk estimates was given as a 2.7 fold increase. This was based on using the 90th percentile of breathing rate distribution. In anticipation of CARB guidance for risk management, we have used the 80th percentile of the breathing rate distribution for ages greater than 2 years. This resulted in a 2.45 fold change in the estimate of risk.

⁶ South Coast Air Quality Management District, Risk Assessments for Rules 1401 and 212. Risk Assessment Procedures for Rules 1401, 1401.1, and 212, Version 8.1, September 1, 2017.
<http://www.aqmd.gov/home/permits/risk-assessment>.

- organ systems (respiratory system, alimentary system, endocrine system, hematologic system, reproductive and development system, cardiovascular system, central nervous system, eyes, kidney, bone and teeth, immune system, skin)
2. For each target organ system:
 - a. Calculate a hazard index by summing the multi-pathway hazard quotient of all species with impacts to the particular target organ
 3. The target organ system with the maximum hazard index represents the chronic non-cancer risk value at the measurement station

Chronic non-cancer risks trends for the MATES II through IV studies were also calculated for this study using the 2015 OEHHA risk assessment methodologies. This provides a consistent comparison across studies for chronic non-cancer risk values between previous MATES and the current study. Maximum hazard indices from all target organ systems are displayed in the Findings section.

2.10 Findings

The findings are presented in terms of the annual average (Kaplan-Meier mean) concentrations of air toxics measured at each site as well as Basin-wide and by the estimated cancer and chronic non-cancer risks resulting from exposures to these average concentrations. See Appendix XI for a description of the statistical handling of data below the method detection limit (MDL) and description of the Kaplan-Meier (KM) mean. In addition to the MATES V data, the data for MATES II through IV were re-analyzed as described in Appendix XI to assess trends in levels of air toxics in the Basin within a consistent analytical framework. In the following charts, the error bars denote the 95% confidence interval of the average based on bootstrap methods. See Chapter 1 for a description of the methods for calculating the cancer and chronic non-cancer risk calculations. Appendix IV contains the results in tabular form, along with plots of the geographic distribution of our findings. Appendix IV also contains a table of the MDLs.

The KM mean cannot be reliably calculated if more than 80% of measurements within a data sample are below the MDL. When the KM mean cannot be calculated, upper and lower bound estimates of the average are provided instead. The lower bound estimate is found by substituting zero for all data below the MDL and calculating the average. The upper bound estimate is found by substituting the MDL for all data below the MDL and calculating the average. This uncertainty is shown in the bar graphs below by shading (diagonal lines on the bars) between the lower and upper bound estimates. The 95% confidence intervals are calculated for the zero-substituted mean using bootstrapping, which is a method of randomly sampling data and re-calculating the mean. 95% confidence intervals are also calculated for the MDL-substituted mean using bootstrapping. In the bar graphs below, the reported lower-bound of the 95% confidence interval is taken from the zero-substituted mean calculations and the upper-bound of the 95% confidence interval is taken from the MDL-substituted mean calculations when the KM mean could not be calculated.

In general, concentrations of most air toxics were substantially lower in MATES V compared to

previous MATES studies. Graphs of the air toxics levels measured in MATES V with health risk assessment values for cancer risk or chronic non-cancer risks are shown below. Tables of results for all measured air toxics are provided in Appendix IV, as well as bar graphs for analytes that do not have risk calculations.

Diesel PM

Diesel Exhaust estimates are shown in Figure 2-3, and the continuation of a trend of decreasing diesel exhaust over time at all stations.

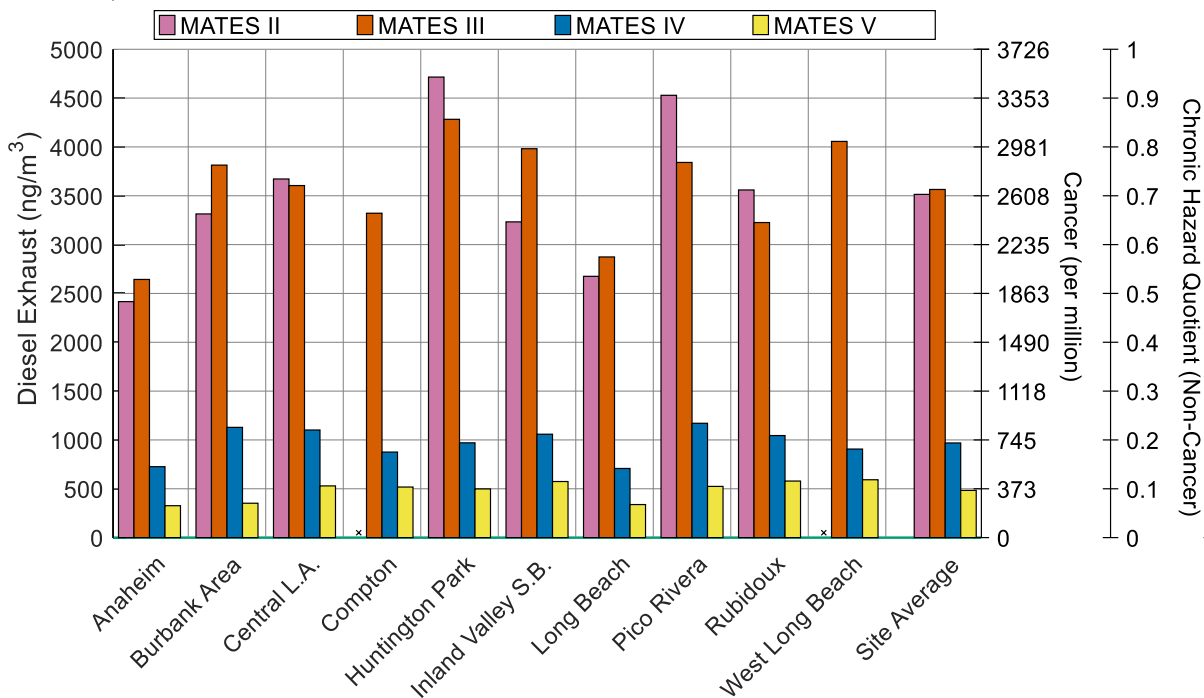


Figure 2-3. Diesel Exhaust Concentration Estimates. “x” indicates that there is no data for a given station/MATES iteration.

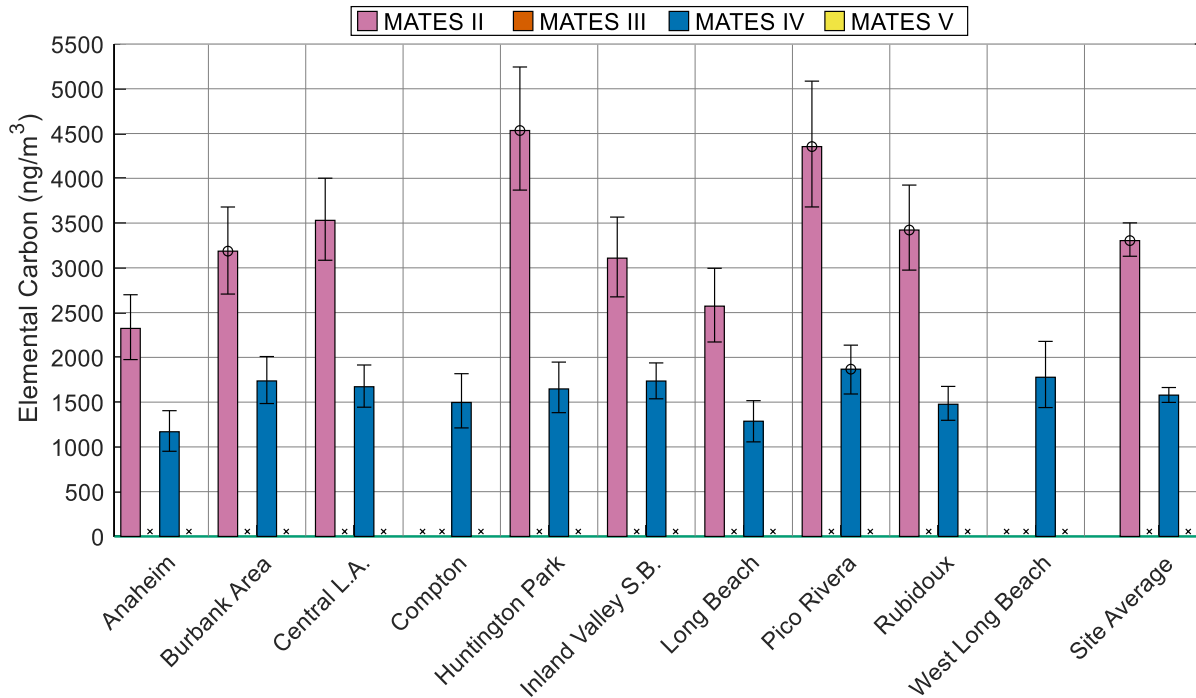


Figure 2-4: Annual Average Concentrations of Elemental Carbon in the PM10 Carbon

Analysis. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. “x” indicates that there is no data for a given station/MATES iteration. Error bars denote the 95% confidence interval.

Volatile Organic Compounds (VOCs) and Carbonyls

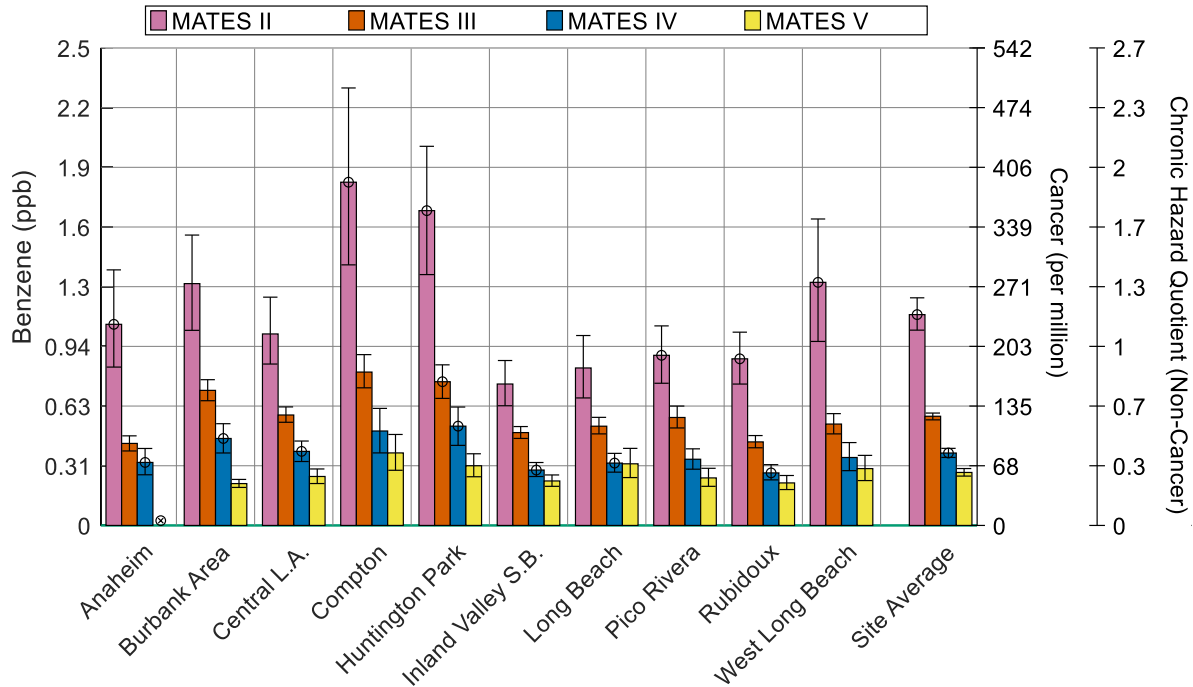


Figure 2-5 and Figure 2-4 present levels for benzene and 1,3-butadiene, which are emitted predominantly from gasoline-powered mobile sources. Both benzene and 1,3-butadiene show a continuing reduction in annual average levels. These decreases are likely reflective of reduced emissions from vehicle fleet turnover to newer vehicles and use of reformulated gasoline. Concentrations of toluene are shown in Figure 2-5. Toluene also shows a continuing decreasing trend. Cancer risks are not shown for toluene because there is insufficient evidence that it is carcinogenic, and therefore OEHHA has not established cancer potency values for this pollutant.

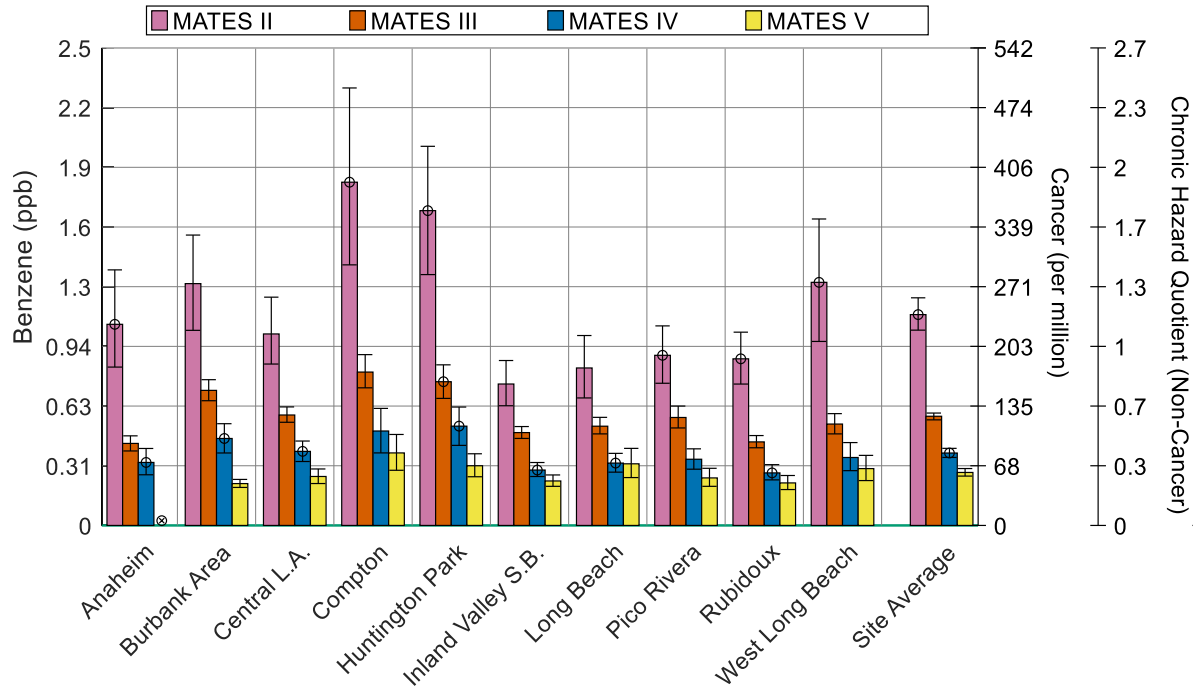


Figure 2-5. Average Concentrations of Benzene. “x” indicates that there is no data for a given station/MATES iteration. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. Error bars denote the 95% confidence interval.

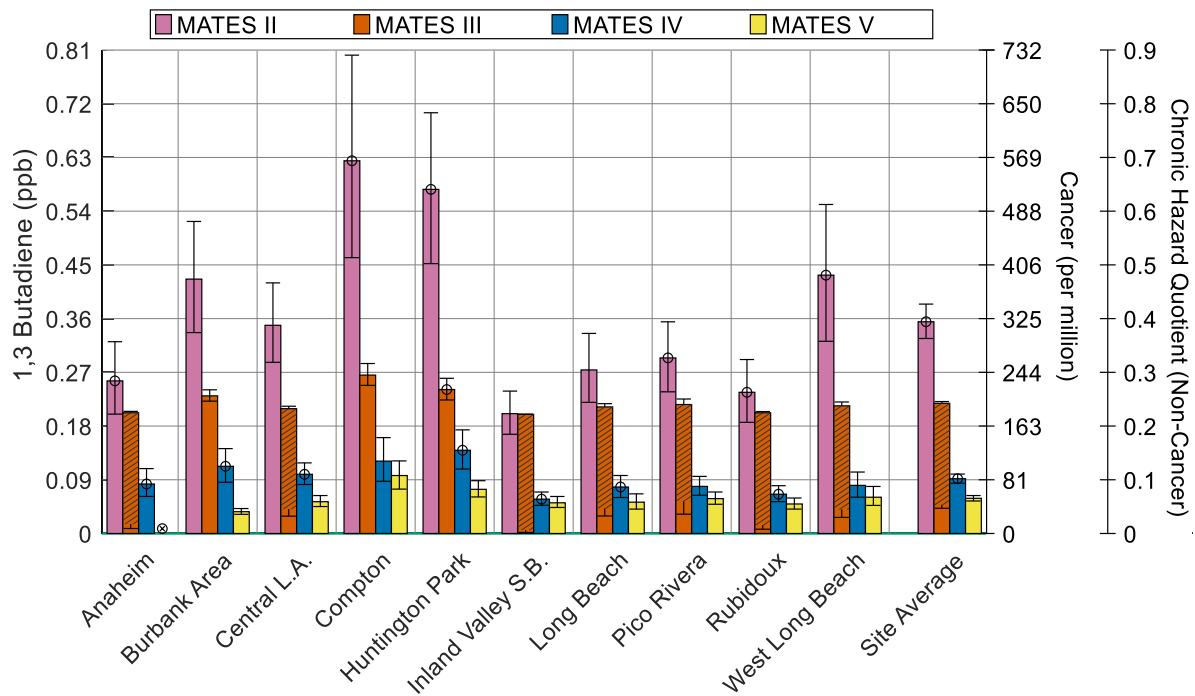


Figure 2-6. Average Concentrations of 1,3 Butadiene. The diagonal lines (shading) on some of the bars for the MATES III stations indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “x” in the place of a bar indicates that there are no data for a given station/MATES iteration. “o” at the top of a bar or in the location of a missing bar indicates that valid measurements do not exist for at least 75% of the sampling days in all quarters. Error bars denote the 95% confidence interval.

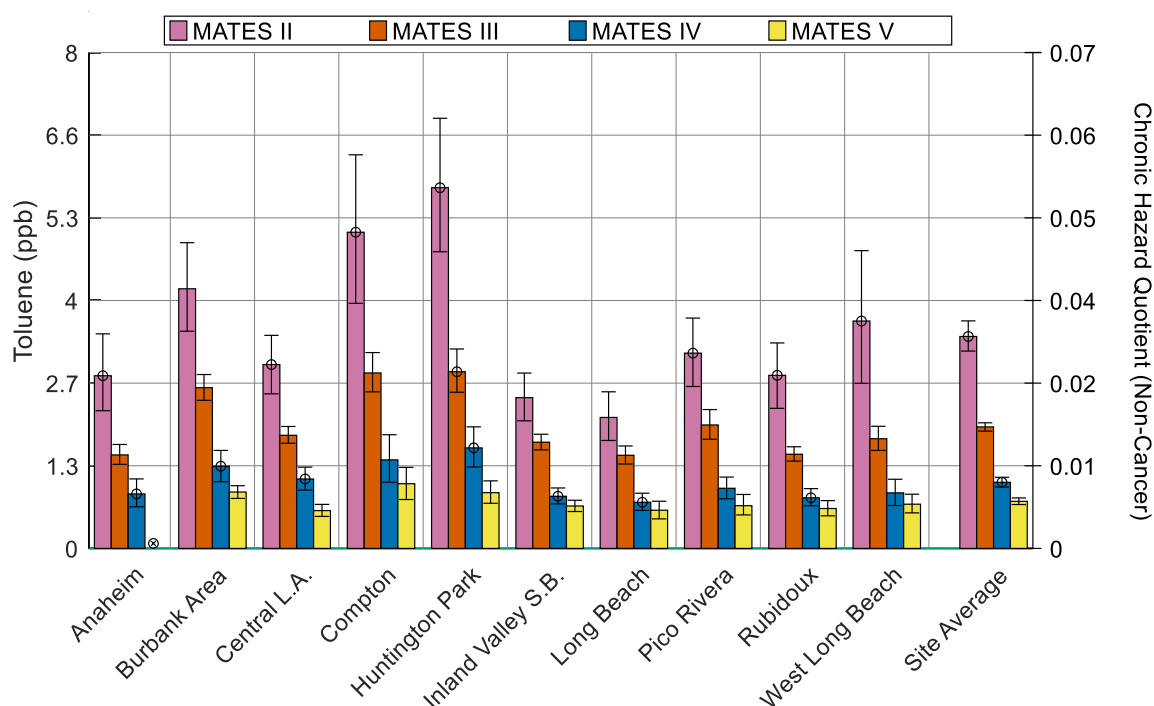


Figure 2-7. Average Concentrations of Toluene. “x” in the place of a bar indicates that there are no data for a given station/MATES iteration. “o” at the top of a bar or in the location of a missing bar indicates that valid measurements do not exist for at least 75% of the sampling days in all quarters. Error bars denote the 95% confidence interval.

Levels of the chlorinated solvents perchloroethylene and methylene chloride are shown in Figure 2-8 and Figure 2-9. Perchloroethylene shows a continuing reduction in levels, likely a result of a number of air quality regulations leading to the gradual phase-out of its use as an industrial and dry cleaning solvent in the South Coast AQMD jurisdiction. Methylene chloride shows a generally downward trend over time, but the trend is not consistent across all stations. The Rubidoux station continued to have the highest levels of methylene chloride, although the levels measured in MATES V are substantially lower than the high levels detected in MATES IV. These levels likely reflect its use as a solvent and may be influenced by specific activities near the monitoring locations.

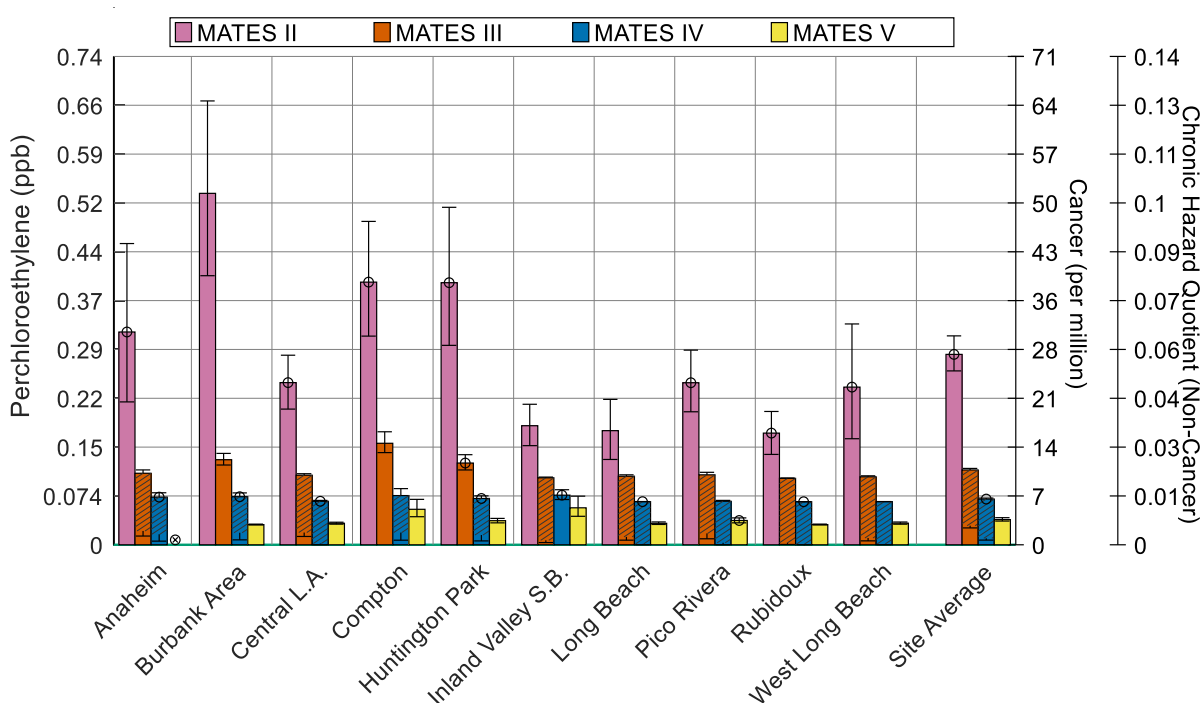


Figure 2-8. Average Concentrations of Perchloroethylene. The diagonal lines (shading) on some of the bars for the MATES III stations indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “x” in the place of a bar indicates that there are no data for a given station/MATES iteration. “o” at the top of a bar or in the location of a missing bar indicates that valid measurements do not exist for at least 75% of the sampling days in all quarters. Error bars denote the 95% confidence interval.

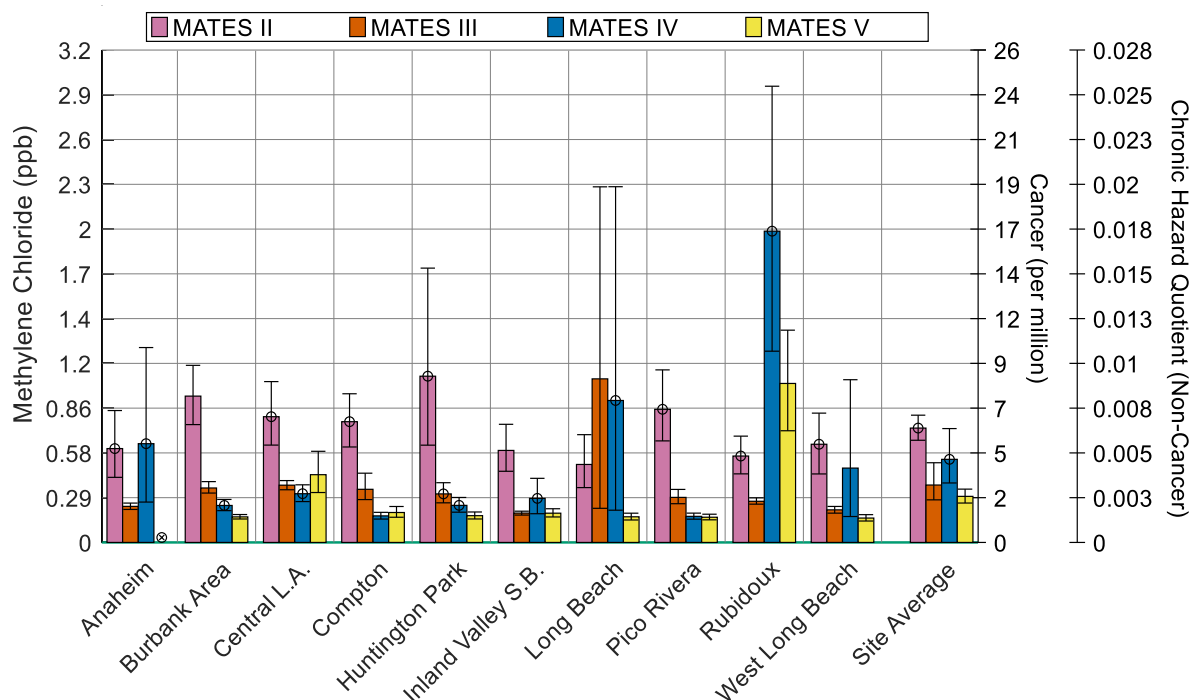


Figure 2-9. Average Concentrations of Methylene Chloride. “x” in the place of a bar indicates that there are no data for a given station/MATES iteration. “o” at the top of a bar or in the location of a missing bar indicates that valid measurements do not exist for at least 75% of the sampling days in all quarters. Error bars denote the 95% confidence interval.

Formaldehyde and acetaldehyde concentrations are shown in Figure 2-10 and Figure 2-11. While MATES IV and V formaldehyde concentrations were generally lower than concentrations measured during MATES II and III, formaldehyde concentrations have increased slightly since MATES IV at the majority of stations. Formaldehyde is emitted from mobile sources and is also formed as a secondary pollutant through chemical reactions of VOCs in the atmosphere. Since secondary formation is a significant source of formaldehyde, it is not possible to ascribe changes to a particular source. Acetaldehyde concentrations do not exhibit a consistent trend over time throughout the Basin. Acetaldehyde is produced by combustion sources and throughout the chemical and food industry.

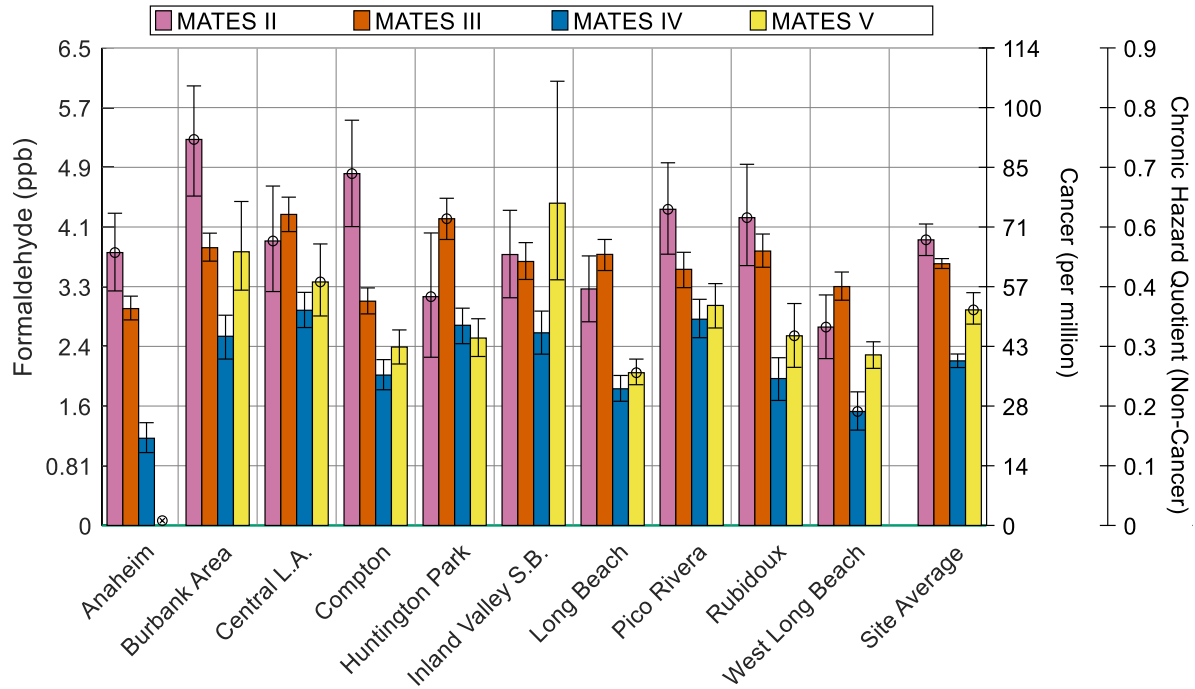


Figure 2-10. Average Concentrations of Formaldehyde. “x” in the place of a bar indicates that there are no data for a given station/MATES iteration. “o” at the top of a bar or in the location of a missing bar indicates that valid measurements do not exist for at least 75% of the sampling days in all quarters. Error bars denote the 95% confidence interval.

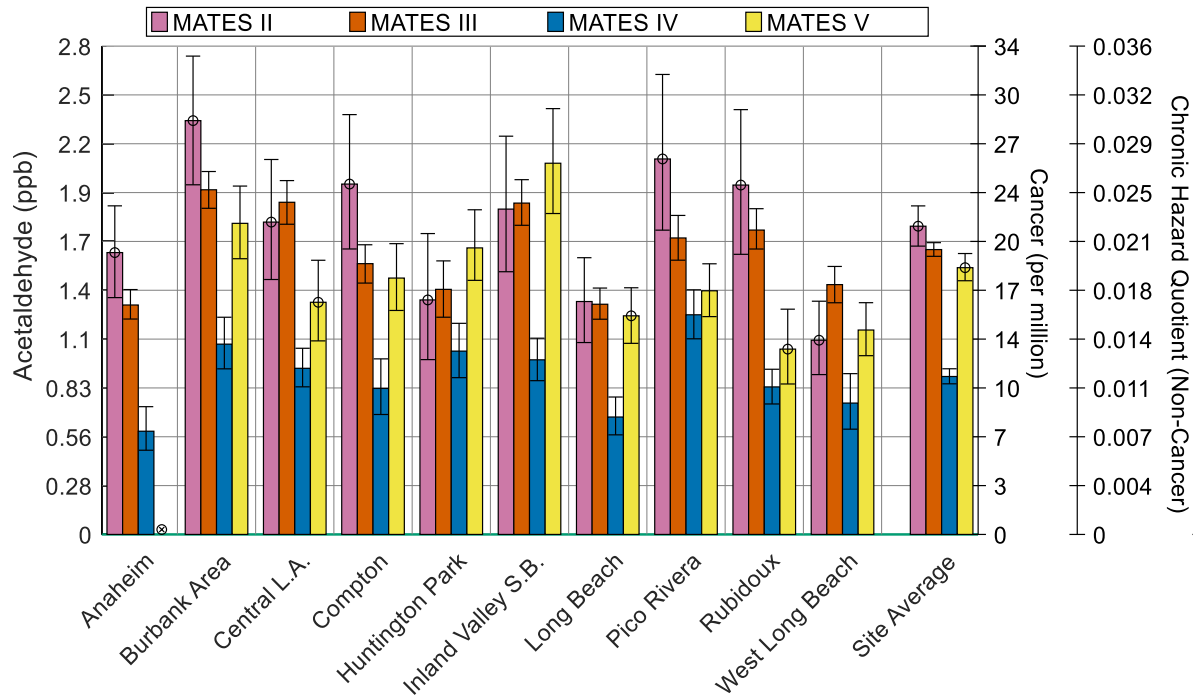


Figure 2-11. Average Concentrations of Acetaldehyde. “x” in the place of a bar indicates that there are no data for a given station/MATES iteration. “o” at the top of a bar indicates that valid measurements do not exist for at least 75% of the sampling days in all quarters. Error bars denote the 95% confidence interval.

Carbon tetrachloride concentrations are shown in Figure 2-12. While uses of carbon tetrachloride as a solvent, in fire extinguishers and in other applications such as cleaning agents has largely been eliminated, some local emissions from industrial sources remain.⁷ In addition, a long atmospheric lifetime of 85 years and previous widespread use results in a global background concentration of approximately 0.07 ppb.^{8,9}

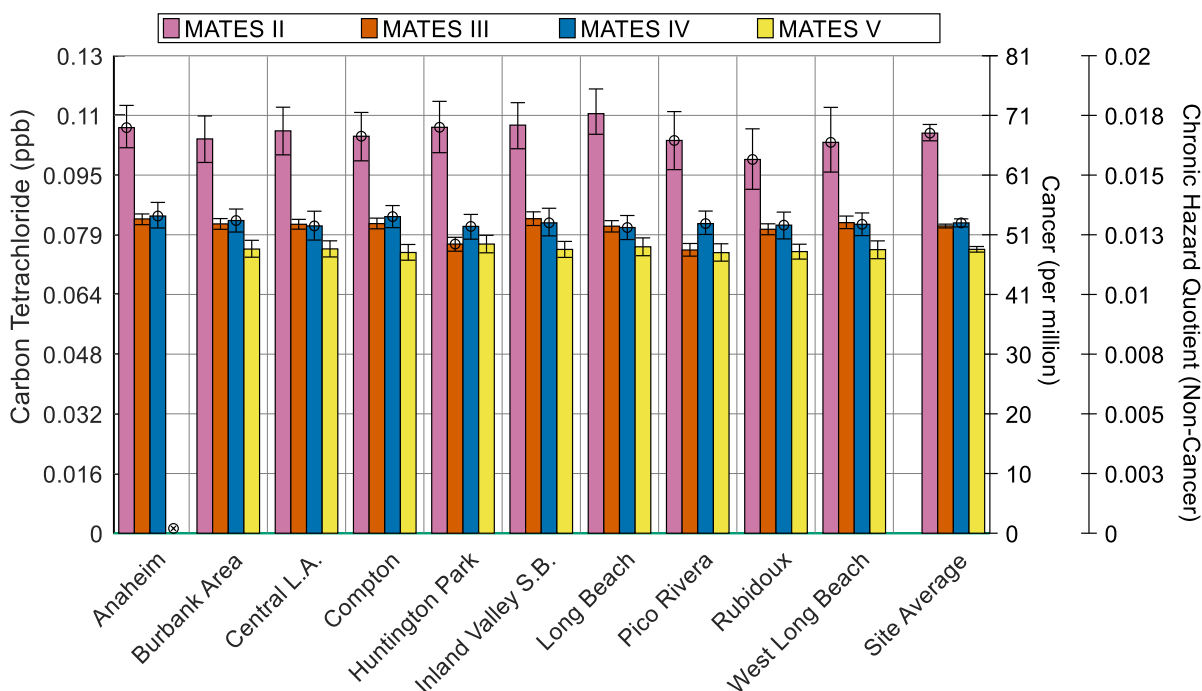


Figure 2-12. Average Concentrations of Carbon Tetrachloride. “x” in the place of a bar indicates that there are no data for a given station/MATES iteration. “o” at the top of a bar or in the location of a missing bar indicates that valid measurements do not exist for at least 75% of the sampling days in all quarters. Error bars denote the 95% confidence interval.

⁷ https://www.epa.gov/sites/production/files/2020-10/documents/1_ccl4_risk_evaluation_for_carbon_tetrachloride.pdf

⁸ https://cdiac.ess-dive.lbl.gov/pns/current_ghg.html

⁹ <https://www.esrl.noaa.gov/gmd/hats/combined/CCl4.html>

Concentrations of ethyl benzene are shown in Figure 2-13. Ethyl benzene shows a continuing reduction in levels at most stations, likely due to reductions of this aromatic compound in fuels, improved vehicle vapor/emission controls, and reduced usage as a solvent. Concentrations of xylene (m-, p-) are shown in Figure 2-14. Similar to ethyl benzene, xylene (m-, p-) and xylene (o-) show a continuing reduction in concentrations for all stations except for the unusually high levels found in MATES IV at the Central L.A. station. Xylene (o-) concentrations are shown in Figure 2-15. Xylene (o-) also had an increase in concentration in MATES IV followed by a decrease in MATES V at Central L.A. The higher average levels of ethyl benzene, xylene (m-, p-), and xylene (o-) at the Central L.A. station during MATES IV were largely due to higher levels observed on a handful of days during the summer of 2012. Such high levels did not recur in MATES V, and the Central L.A. station showed levels of these VOCs that were similar to the other locations. Most stations show reductions in levels of xylene (o-) during MATES II through IV, however MATES V xylene (o-) concentrations are similar to those of MATES IV at most stations. Cancer risks are not shown for xylene (m-, p-) and xylene (o-) because OEHHA has not established cancer risk potency values for xylene (m-, p-) and xylene (o-).

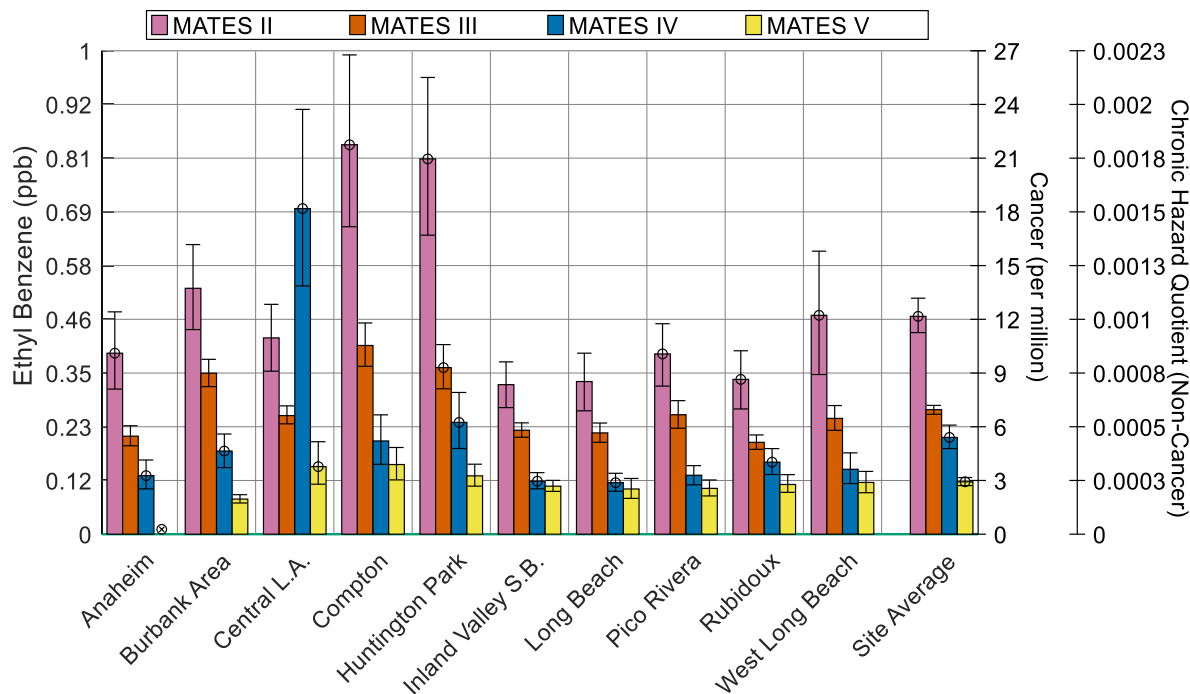


Figure 2-13. Average Concentrations of Ethyl Benzene. “x” in the place of a bar indicates that there are no data for a given station/MATES iteration. “o” at the top of a bar or in the location of a missing bar indicates that valid measurements do not exist for at least 75% of the sampling days in all quarters. Error bars denote the 95% confidence interval.

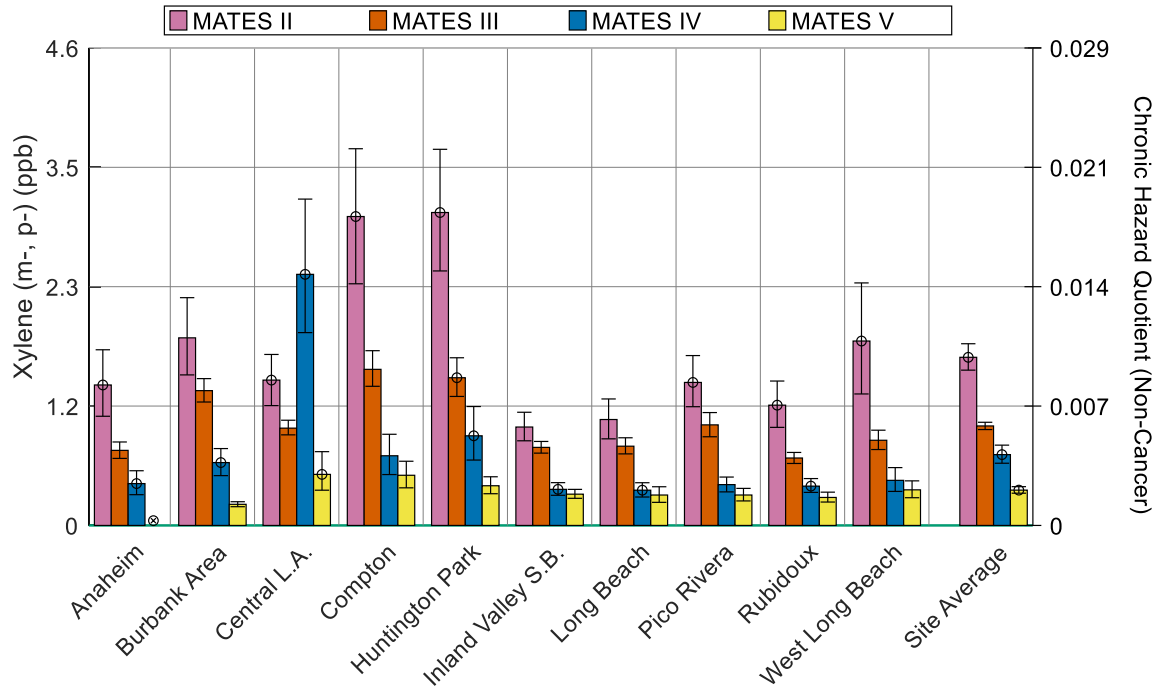


Figure 2-14. Average Concentrations of Xylene (m-, p-). “x” in the place of a bar indicates that there are no data for a given station/MATES iteration. “o” at the top of a bar or in the location of a missing bar indicates that valid measurements do not exist for at least 75% of the sampling days in all quarters. Error bars denote the 95% confidence interval.

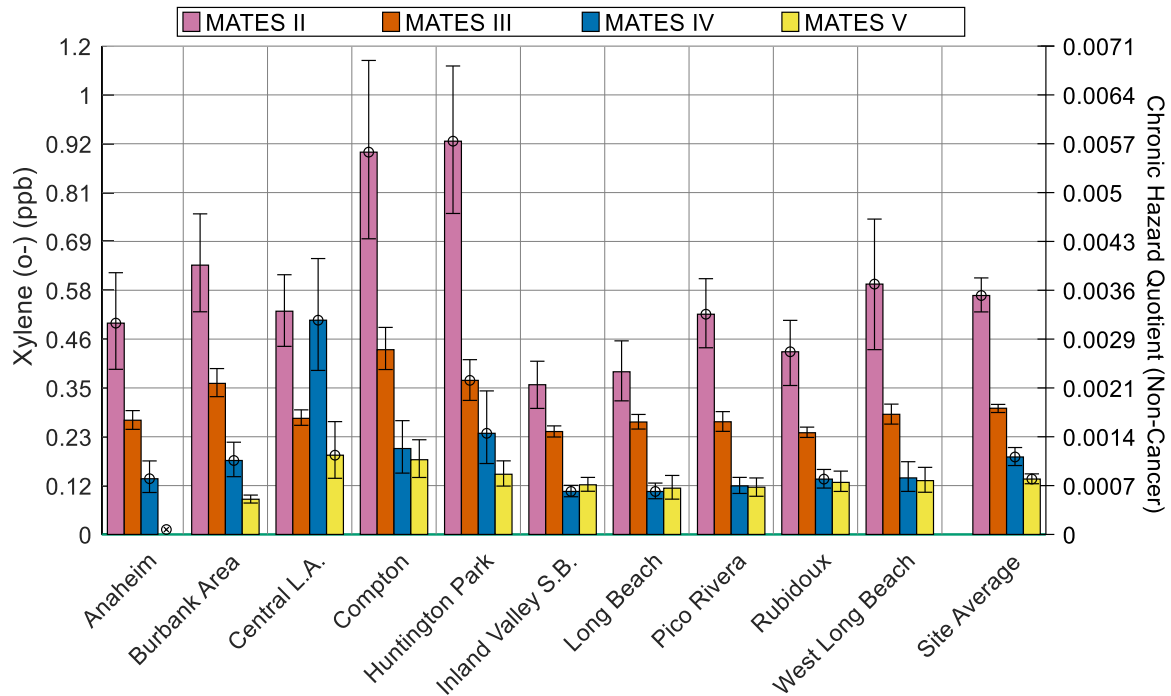


Figure 2-15. Average Concentrations of Xylene (o-). “x” in the place of a bar indicates that there are no data for a given station/MATES iteration. “o” at the top of a bar or in the location of a missing bar indicates that valid measurements do not exist for at least 75% of the sampling days in all quarters. Error bars denote the 95% confidence interval.

Concentrations of acrolein (2-propenal) are shown in Figure 2-16. Concentrations of acrolein increased at most stations from MATES IV to V. Acrolein was not measured during MATES II or III. Acrolein is formed from combustion processes and reaction of other VOCs in the atmosphere. The accuracy of measurement methods for acrolein have been called into question and there is no CARB-approved test method for acrolein from stationary sources.¹⁰ Therefore, these data should be interpreted with caution. Cancer risks are not shown for Acrolein because OEHHA does not have cancer risk assessment values for this pollutant.

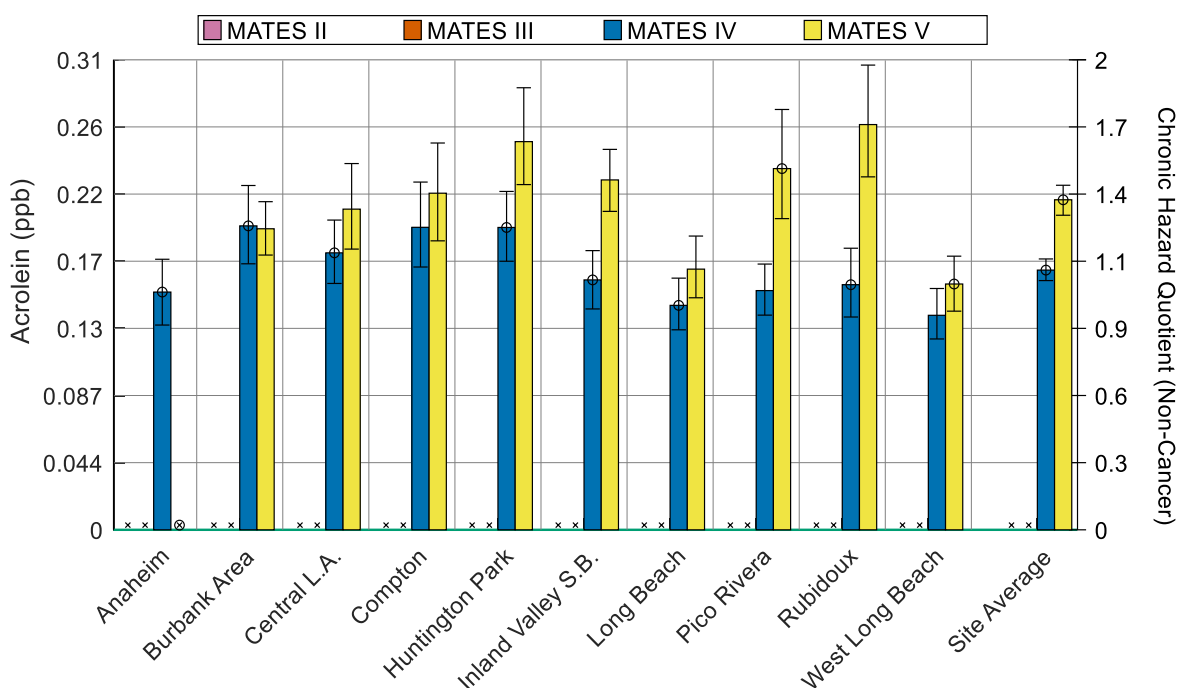


Figure 2-16. Average Concentrations of Acrolein. “x” in the place of a bar indicates that there are no data for a given station/MATES iteration. “o” at the top of a bar or in the location of a missing bar indicates that valid measurements do not exist for at least 75% of the sampling days in all quarters. Error bars denote the 95% confidence interval.

¹⁰ <https://ww2.arb.ca.gov/acrolein-test-method-advisory-and-data>

Concentrations of bromomethane (methyl bromide) are shown in Figure 2-17. Bromomethane was not measured in previous MATES projects. The concentrations at West Long Beach are substantially higher than all other stations. Bromomethane is used as a fumigant for agricultural products, and some fumigation facilities are located near the ports. One such facility is located a few hundred feet west of the West Long Beach MATES station; these localized emissions could have influenced the levels detected in this location. Cancer risks are not shown for bromomethane because there are no cancer potency values for bromomethane established by OEHHA.

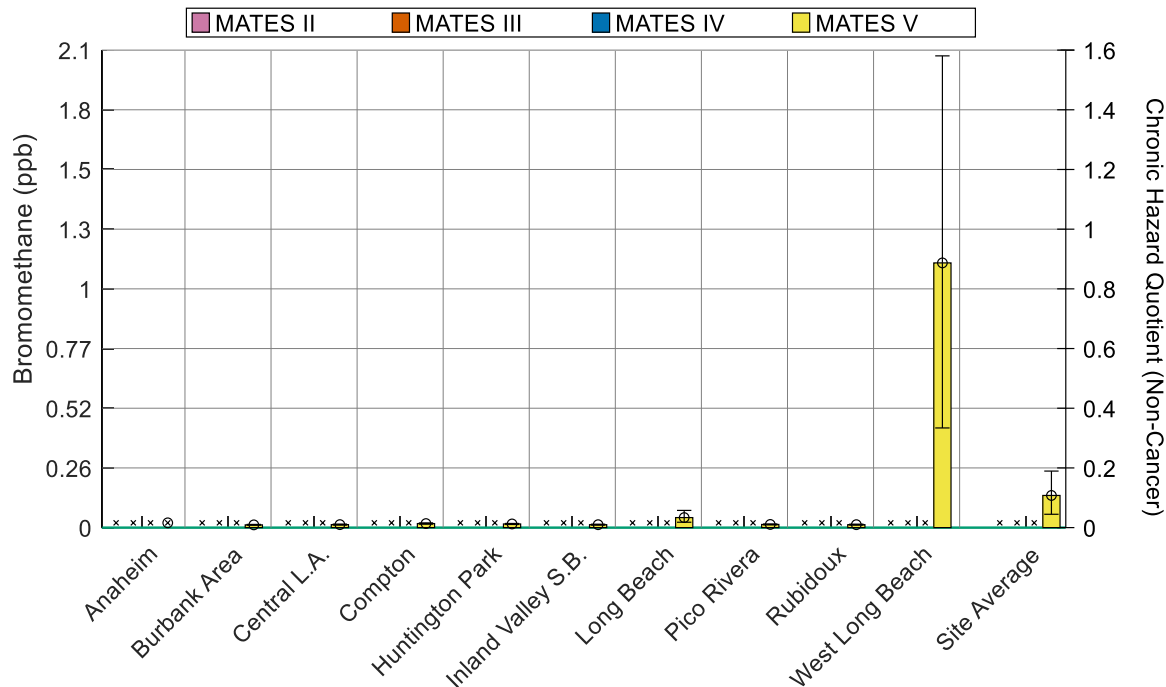


Figure 2-17. Average Concentrations of Bromomethane. “x” indicates that there is no data for a given station/MATES iteration. Note that bromomethane measurements began on August 12, 2018 and therefore, do not constitute a complete year of measurements. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. Error bars denote the 95% confidence interval.

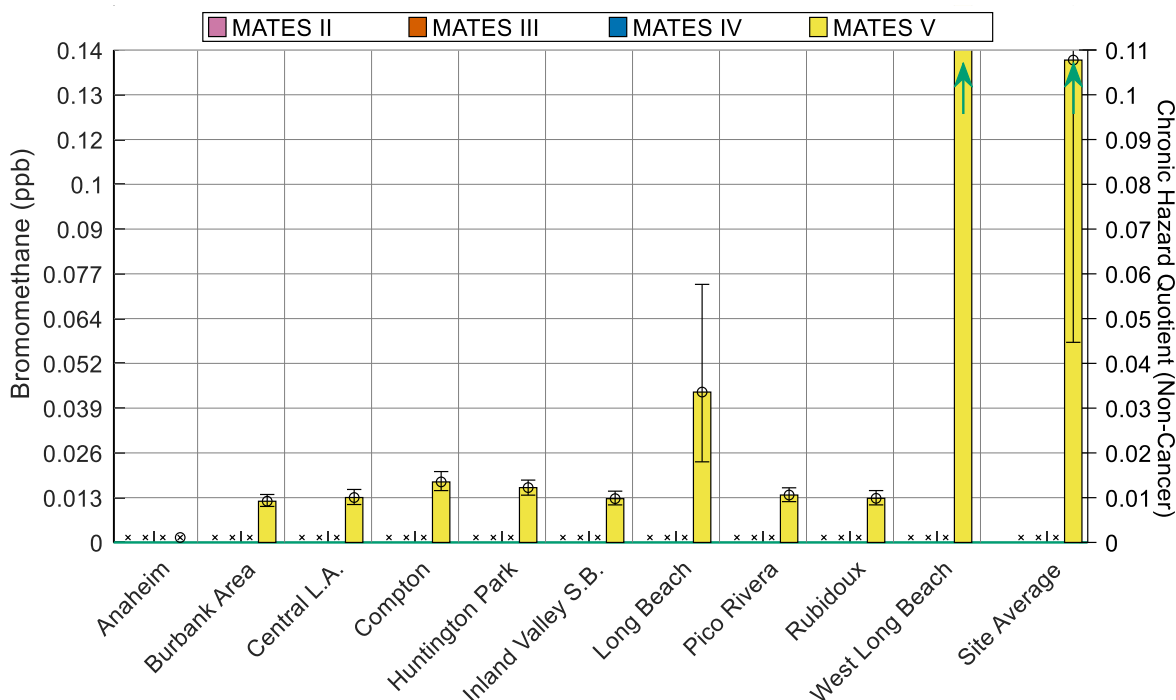


Figure 2-18. Average Concentrations of Bromomethane. “x” indicates that there is no data for a given station/MATES iteration. Note that bromomethane measurements began on August 12, 2018 and therefore, do not constitute a complete year of measurements. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. Error bars denote the 95% confidence interval.

Concentrations of 1,4-Dichlorobenzene are shown in Figure 2-19. The shading on a bar indicates that more than 80% of the data used to calculate that bar were below detection limit. Caution should be used when interpreting trends with shaded bars since the height of shaded bars represent upper bound estimates using MDL substitution for data below the detection limit. However, since the KM mean was calculated for the MATES II data (i.e., those bars are not shaded) and the upper bound estimates of the MATES V data are substantially lower than the MATES II KM means, we conclude that there has been a substantial decline in 1,4-Dichlorobenzene concentrations from MATES II to MATES V.

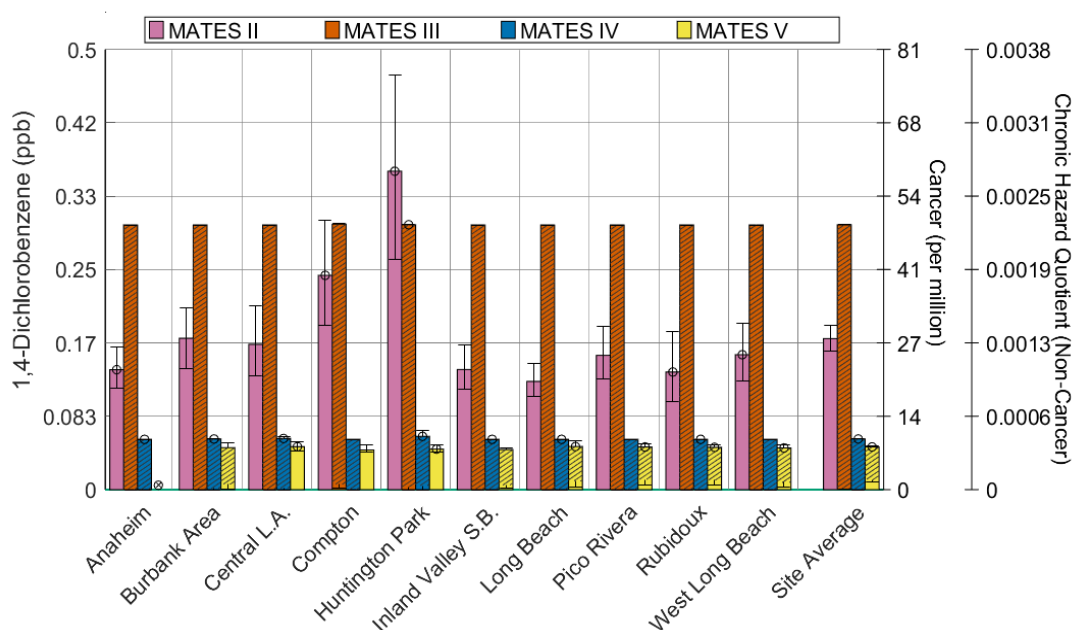


Figure 2-19. Average Concentrations of 1,4-Dichlorobenzene. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “x” in the place of a bar indicates that there are no data for a given station/MATES iteration. “o” at the top of a bar or in the location of a missing bar indicates that valid measurements do not exist for at least 75% of the sampling days in all quarters. Error bars denote the 95% confidence interval.

Concentrations of trichloroethylene are shown in Figure 2-20. The shading on a bar indicates that more than 80% of the data used to calculate that bar were below detection limit. Caution should be used when interpreting trends with shaded bars since the height of shaded bars represent upper bound estimates using MDL substitution for data below the detection limit. However, since the KM mean was calculated for the MATES II data (i.e., those bars are not shaded) and the upper bound estimates of the MATES V data are lower than the MATES II KM means at most stations, we conclude that there has been a decline in trichloroethylene concentrations from MATES II to MATES V at most stations.

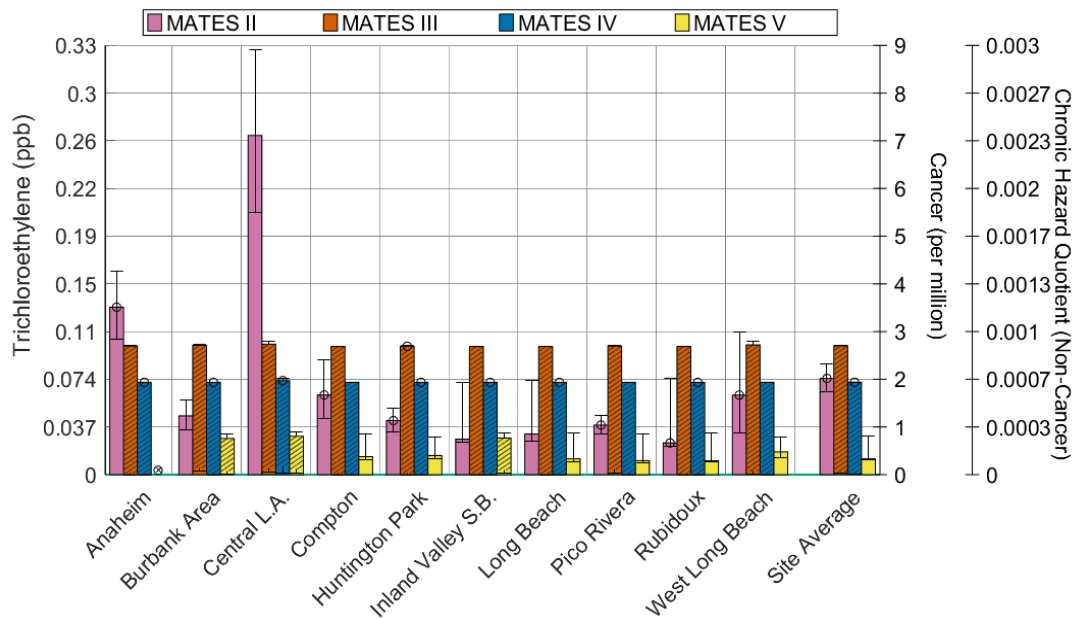


Figure 2-20. Average Concentrations of Trichloroethylene. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “x” in the place of a bar indicates that there are no data for a given station/MATES iteration. “o” at the top of a bar or in the location of a missing bar indicates that valid measurements do not exist for at least 75% of the sampling days in all quarters. Error bars denote the 95% confidence interval.

Styrene concentrations are shown in Figure 2-21. Styrene concentrations have decreased at all stations since MATES II.

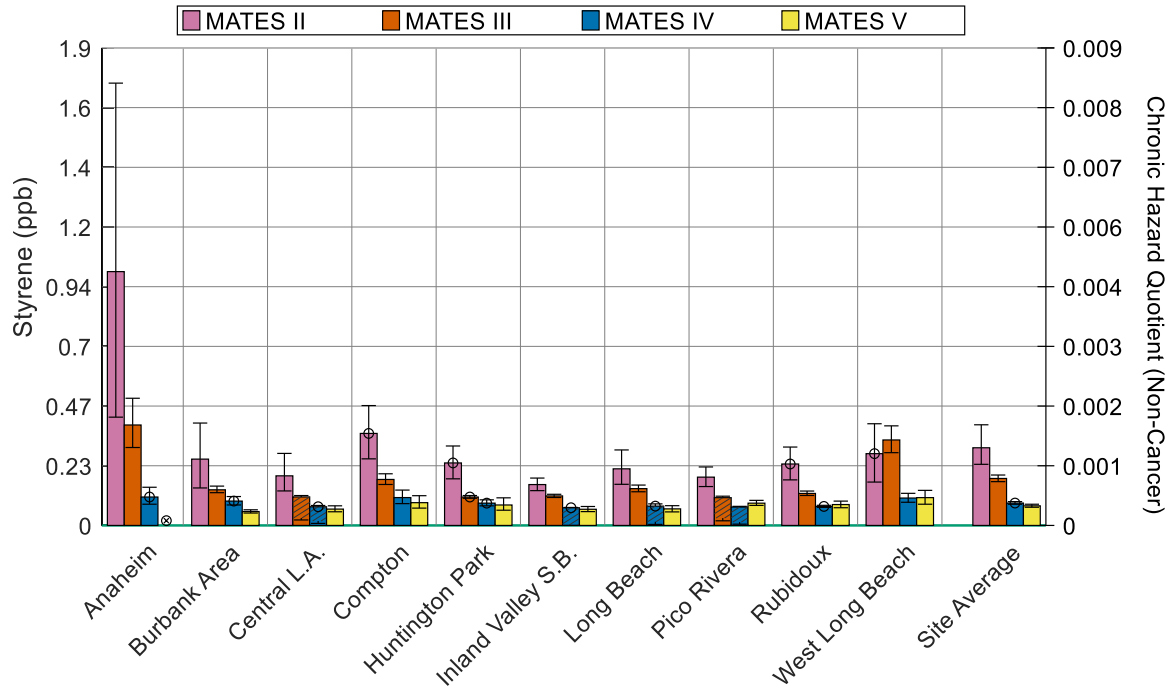


Figure 2-21. Average Concentrations of Styrene. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “x” in the place of a bar indicates that there are no data for a given station/MATES iteration. “o” at the top of a bar or in the location of a missing bar indicates that valid measurements do not exist for at least 75% of the sampling days in all quarters. Error bars denote the 95% confidence interval.

Concentrations of chloroform are shown in Figure 2-22. Chloroform concentrations have declined substantially from MATES II to MATES V at Burbank Area and Huntington Park stations, with modest declines at most other stations. More than 80% of measurements at most stations were below the MDL during MATES III and IV, as indicated by the shaded bars in Figure 2-22. The height of the shaded bars indicates upper bound estimates of the average annual concentrations.

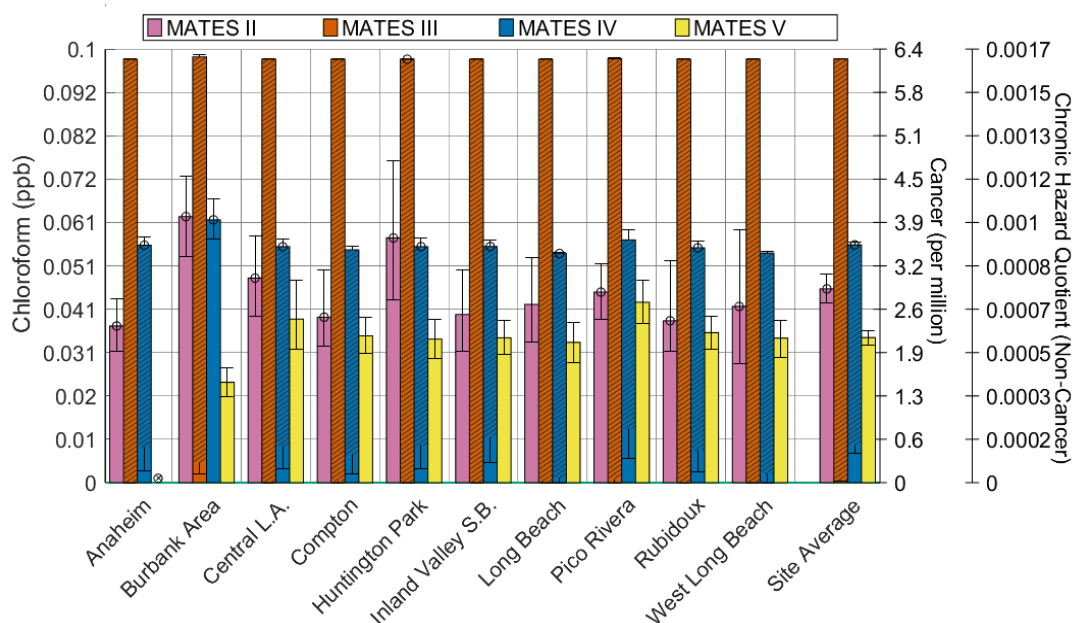


Figure 2-22. Average Concentrations of Chloroform. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “x” in the place of a bar indicates that there are no data for a given station/MATES iteration. “o” at the top of a bar or in the location of a missing bar indicates that valid measurements do not exist for at least 75% of the sampling days in all quarters. Error bars denote the 95% confidence interval.

Concentrations of 1,2-Dichloroethane are shown in Figure 2-23. The shading on the bars indicates that 80% of the data were below their MDL at all stations for most of the MATES projects (all except MATES V). This means that changes in the height of the bars over time are primarily reflective of changes of MDLs over time, and trends in concentrations over time cannot be determined from these data. The data do provide lower and upper bound estimates of average annual concentrations.

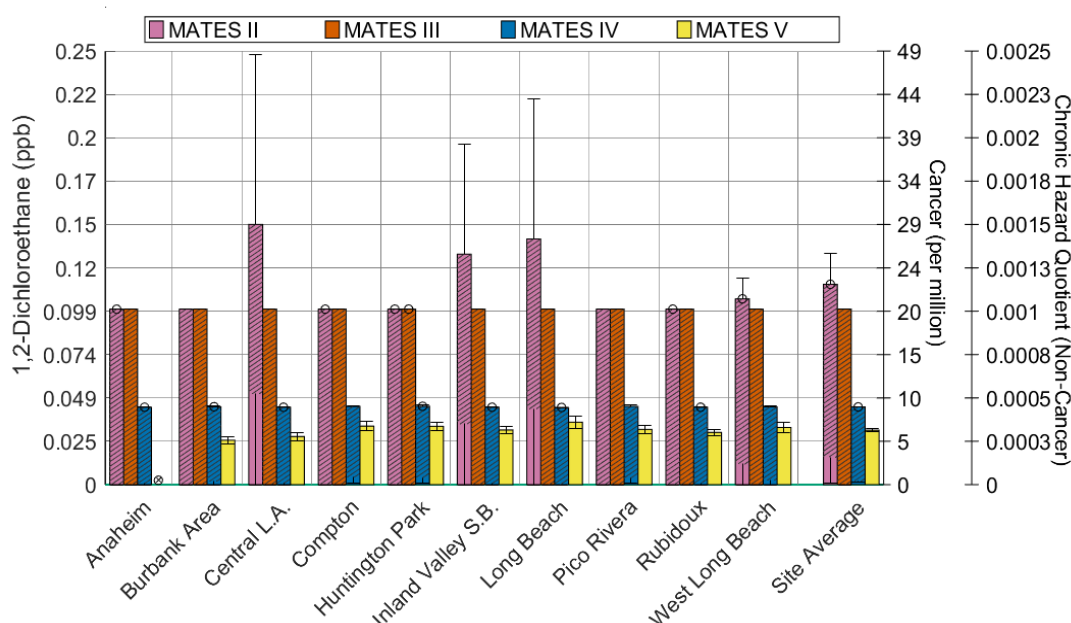


Figure 2-23. Average Concentrations of 1,2-Dichloroethane. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “x” in the place of a bar indicates that there are no data for a given station/MATES iteration. “o” at the top of a bar or in the location of a missing bar indicates that valid measurements do not exist for at least 75% of the sampling days in all quarters. Error bars denote the 95% confidence interval.

More than 80% of the measurements of vinyl chloride and Methyl tertiary-butyl ether (MTBE) were below their MDLs at all stations for all MATES studies. All measurements of 1,2-Dibromoethane were below their MDLs at all stations for all MATES studies. Therefore, the MATES studies are not able to provide significant information on trends in these pollutant concentrations over time.

Metals

Airborne arsenic levels are shown in Figure 2-24. The shading on all of the MATES II bars in Figure 2-24 indicates that more than 80% of all measurements were below their MDLs at all stations for MATES II. The heights of the MATES II bars provide upper bound estimates of the average annual concentrations and cannot be used for determining trends over time. Figure 2-24 indicates the TSP arsenic concentrations have decreased between MATES III and MATES V in eight out of ten stations. The error bars for MATES V at West Long Beach are wide and overlap with the MATES III concentration. More than 80% of the MATES III Anaheim measurements were below the MDL and cannot be used for determining trends. There is an increase in TSP

arsenic concentrations from MATES IV to V at Anaheim, although the levels at this station are lower than the other MATES stations. There is a decline in TSP arsenic at Central L.A. from MATES IV to MATES V. Other stations show little change in TSP arsenic from MATES IV to MATES V. Sources of arsenic include paved road dust, construction dust, mineral processes, metal processes, refineries and fuel combustion.

The TSP arsenic concentrations from MATES V are consistent with those measured at most of the 79 sites in 13 states around the U.S. in the Ambient Monitoring Archive (AMA) for 2017 (<https://www3.epa.gov/ttn/amtic/toxdat.html#data>). South Coast AQMD staff analyzed the 2017 AMA data using the same methods used for the MATES data (see Appendix XI). One site in Pennsylvania has a 95% confidence interval entirely lower than the 95% confidence intervals observed for the SoCAB for MATES V. One site near Bakersfield, CA and three sites in Ohio have 95% confidence intervals that are entirely above the 95% confidence intervals seen in MATES V. All other sites in the AMA data have 95% confidence intervals that overlap with those of MATES V.

The Bay Area Air Quality Management District's CARE study¹¹ reported that arsenic and mercury were major contributors to the chronic non-cancer health risk related to the nervous system, based on three years of monitoring data (2010-2013) from a site in Cupertino located half a mile from a cement plant. While this site is likely not representative of most residential locations, it does provide a point of comparison. Average arsenic levels found in the CARE study Cupertino site was 0.12 ng/m³, which is lower than the average levels found in MATES V.

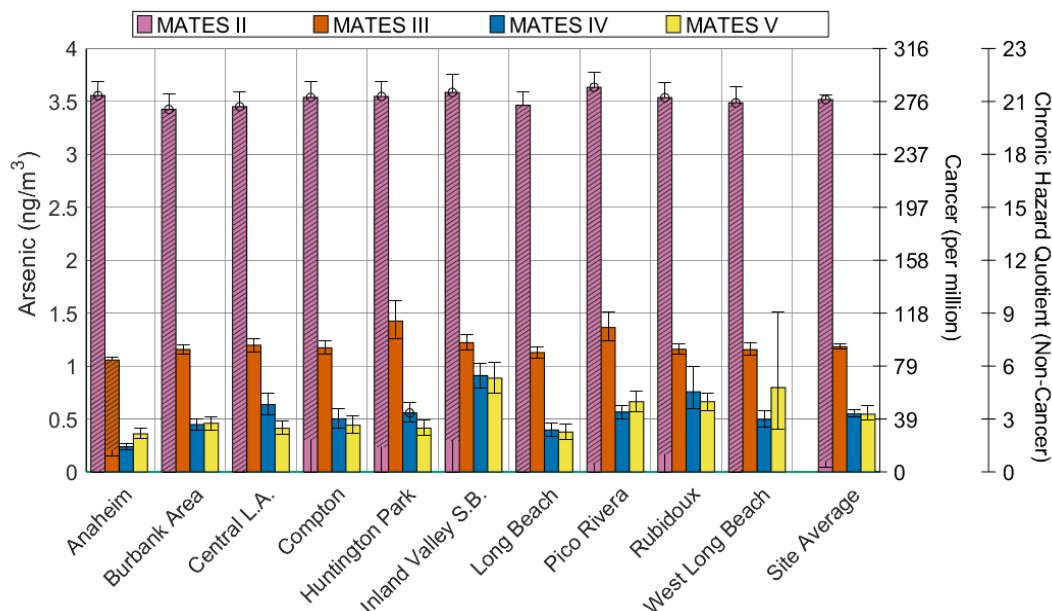


Figure 2-24. Average Concentrations of Arsenic in Total Suspended Particulate (TSP). The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those

¹¹

https://www.baaqmd.gov/~media/Files/Planning%20and%20Research/CARE%20Program/Documents/CARE_Retrrospective_April2014.ashx?la=en

stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. Error bars denote the 95% confidence interval.

Figure 2-25 and Figure 2-26 show TSP cadmium. Figure 2-25 indicates that more than 80% of the measurements were below their MDLs at all stations in MATES II. The heights of the MATES II bars provide upper bound estimates of the average annual concentrations and cannot be used for determining trends over time. Figure 2-26 shows that the KM means for Huntington Park, Inland Valley San Bernardino, Rubidoux, and West Long Beach are much lower in MATES IV and MATES V compared to MATES III. Of these stations, MATES V is higher than MATES IV for Huntington Park, Rubidoux, and West Long Beach, while Inland Valley San Bernardino is similar between MATES IV and MATES V. For the remaining stations, more than 80% of the MATES III data were below detection limits. The lower edge of the shading is the mean using zero-substitution for the data that were below detection limit and the lower edge of the corresponding error bar represents the lower 95% confidence limit based on zero-substitution (in order to give lower-bound estimates). For the Anaheim, Central L.A., Compton, Long Beach, and Pico Rivera, the MATES V data is clearly lower than the lower-bound estimates for the MATES III data. TSP cadmium concentrations increased from MATES IV to MATES V at Anaheim and decreased at Long Beach. Trends from MATES IV to MATES V are less significant at Burbank Area, Central L.A., Compton, and Pico Rivera since the error bars overlap.

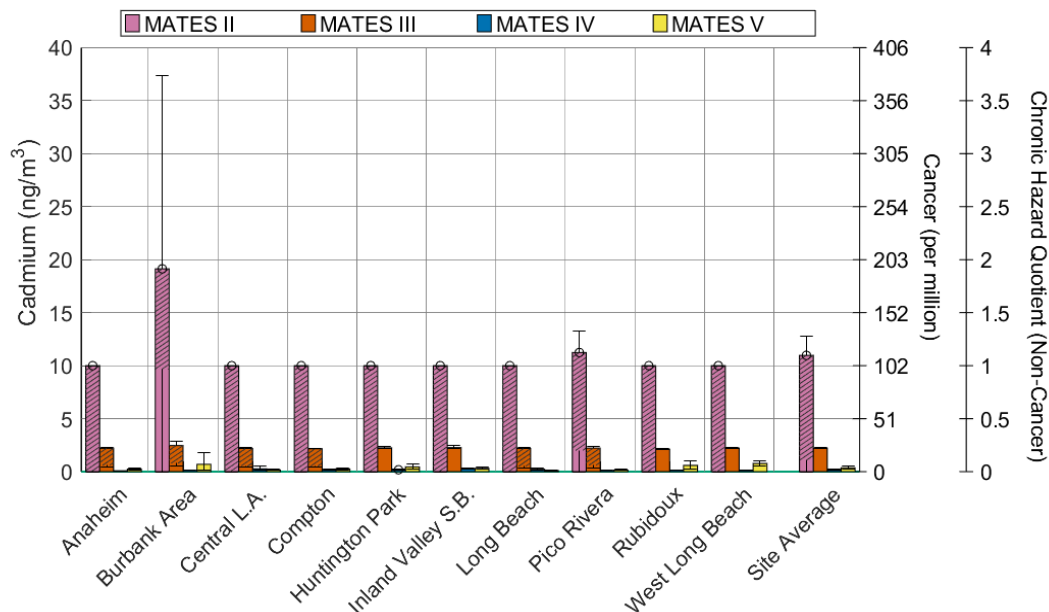


Figure 2-25. Average Concentrations of Cadmium in Total Suspended Particulate (TSP). The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading

shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. Error bars denote the 95% confidence interval.

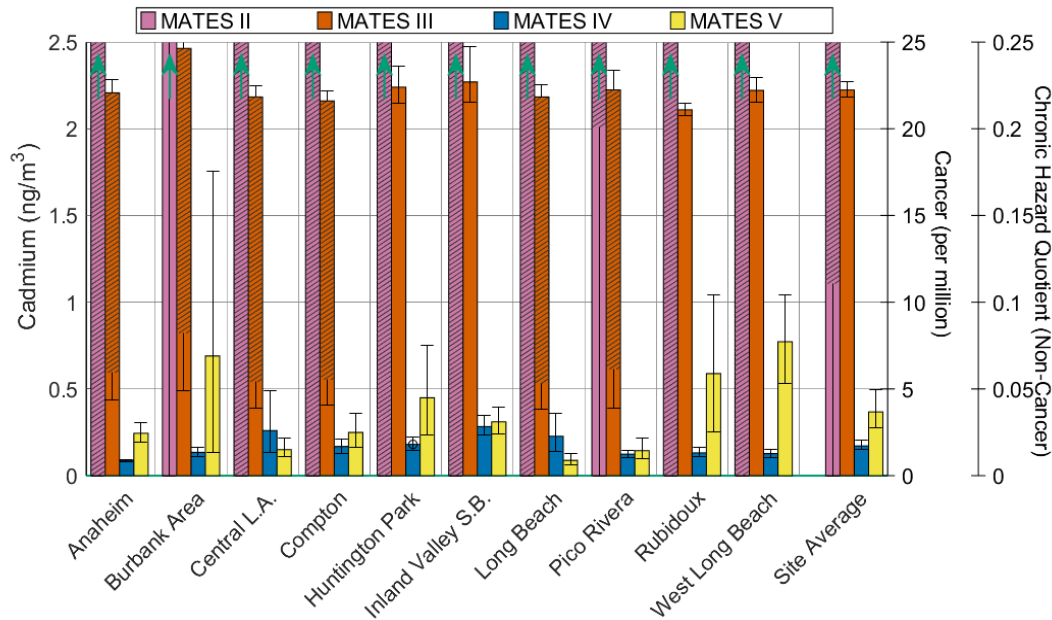


Figure 2-26. Average Concentrations of Cadmium in Total Suspended Particulate (TSP).

The upward arrows indicate that the data extends above the y-axis shown. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. Error bars denote the 95% confidence interval.

Figure 2-27, Figure 2-28 and Figure 2-29 show the levels of two more air toxics, lead and nickel. Lead concentrations were reduced in MATES IV and MATES V compared to MATES II and MATES III, and the values are well below the National Ambient Air Quality Standard of 150 ng/m³. Lead concentrations decreased at Central L.A. from MATES IV to MATES V. Other stations do not show no significant trends in lead concentrations from MATES IV to MATES V since the error bars overlap. Nickel concentrations also decreased over time Basin-wide and at most sites. Inland Valley San Bernardino is the only station to show insignificant declines in nickel concentrations between MATES II and MATES V.

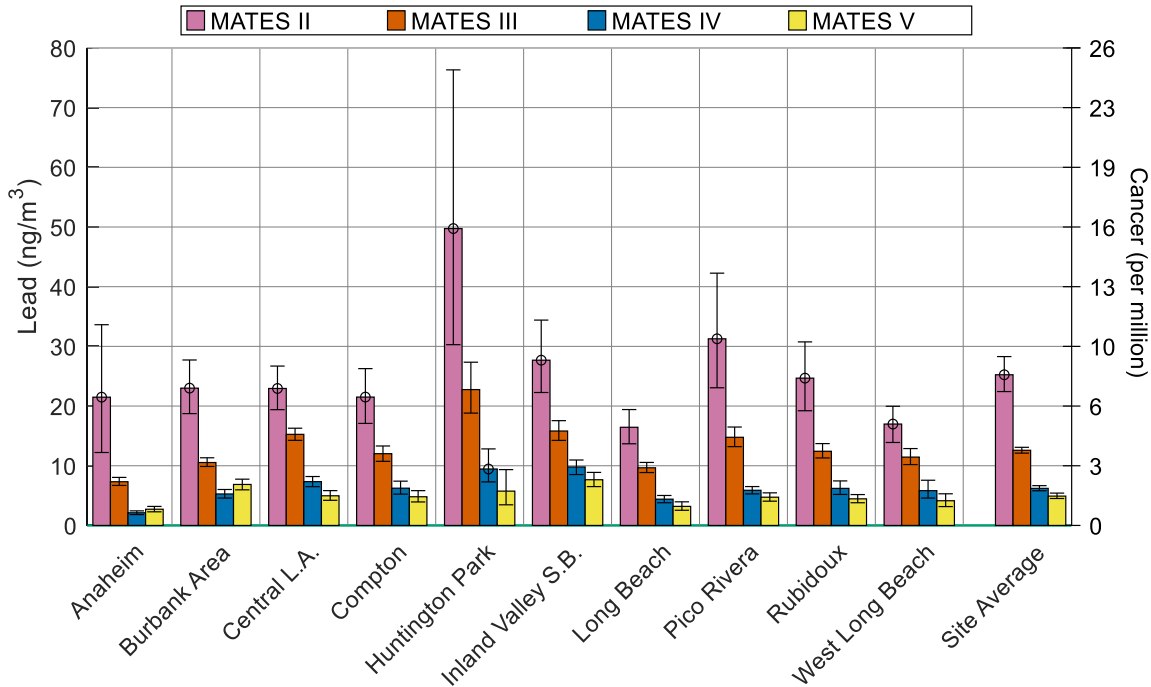


Figure 2-27. Average Concentrations of TSP Lead. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. Error bars denote the 95% confidence interval.

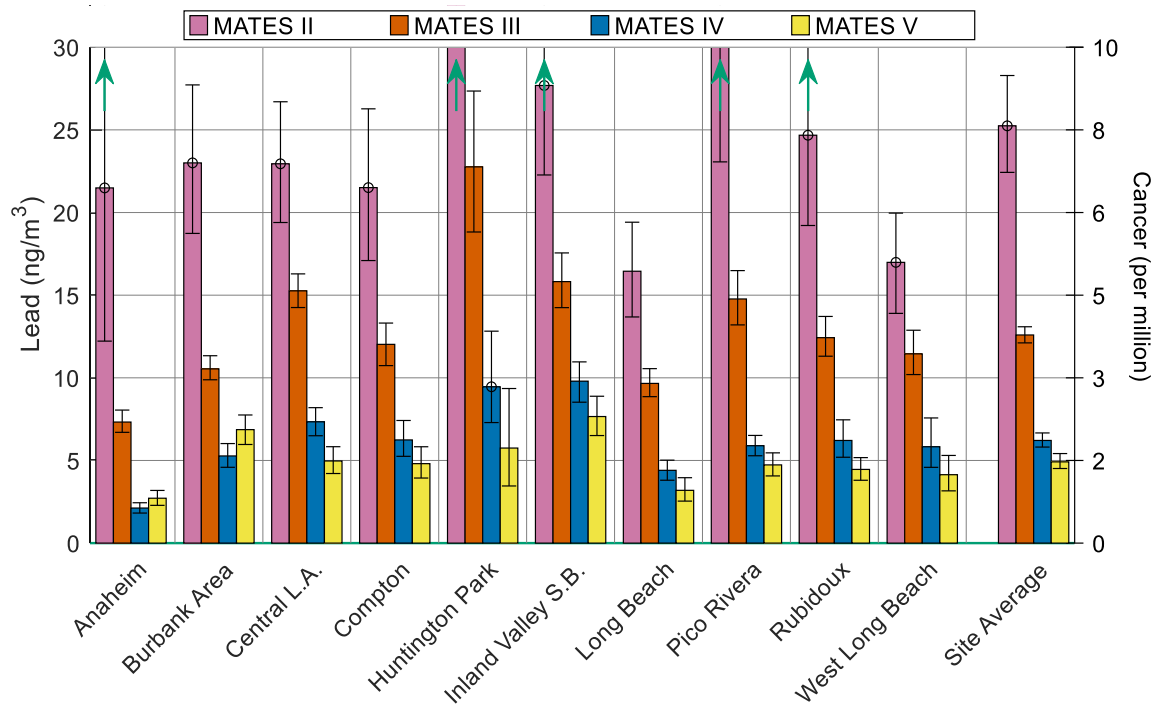


Figure 2-28. Average Concentrations of TSP Lead. The upward arrows indicate that the data extends above the y-axis shown. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. Error bars denote the 95% confidence interval.

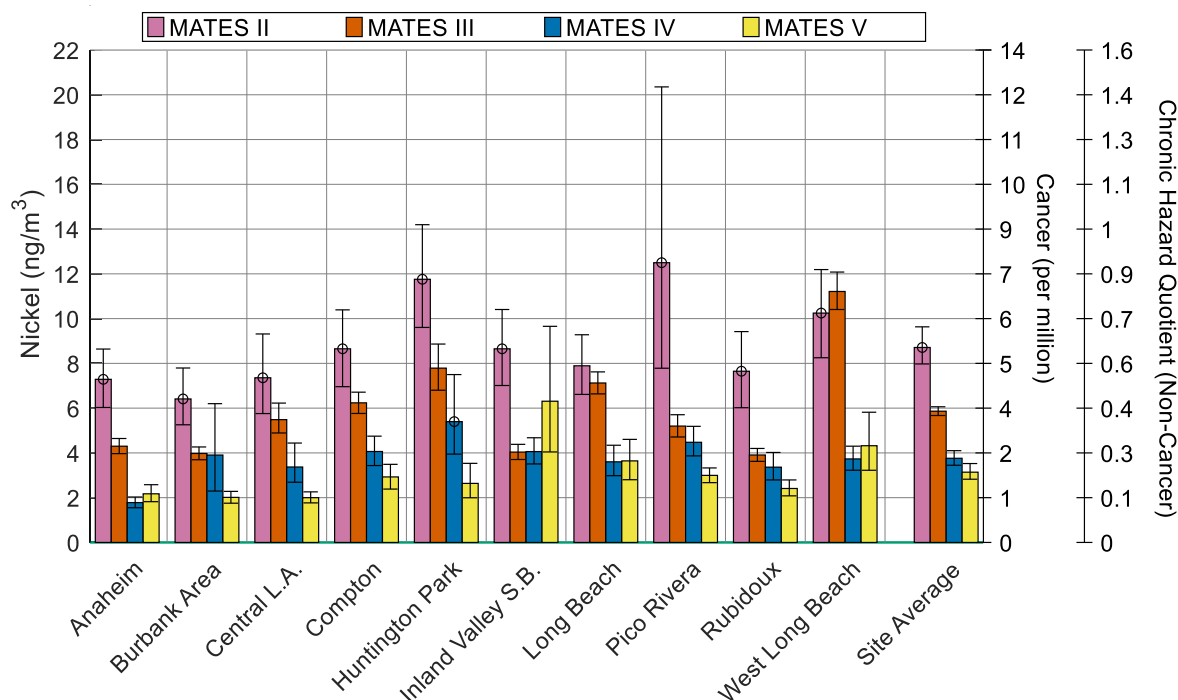


Figure 2-29. Average Concentrations of TSP Nickel. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. Error bars denote the 95% confidence interval.

Hexavalent chromium concentrations are shown in Figure 2-30 and Figure 2-31. Note as found in previous studies, localized increases in hexavalent chromium can occur near facilities using hexavalent chromium-containing materials, such as metal platers, facilities using chromate paints, or cement manufacturing and batch plants. The monitoring locations in this study, however, are intended to measure regional levels of air toxics rather than air toxics levels near area sources. Thus, localized areas of enhanced exposure may not be reflected in these monitoring efforts. For most locations, the annual averages at the monitored locations were substantially lower in MATES IV and MATES V than in previous MATES. For MATES III, the Rubidoux site showed an increase in average hexavalent chromium levels which were eventually traced to cement plants in the region. This led to the adoption of amendments to South Coast AQMD rules for cement facilities addressing hexavalent chromium emissions. The level reductions from MATES IV and MATES V reflect these rule changes as well as reduced activity at the cement plants with hexavalent chromium levels greatly reduced and now comparable to those of other sites. Ongoing regulatory programs also help to reduce hexavalent chromium emissions from stationary sources, such as metal processing facilities.

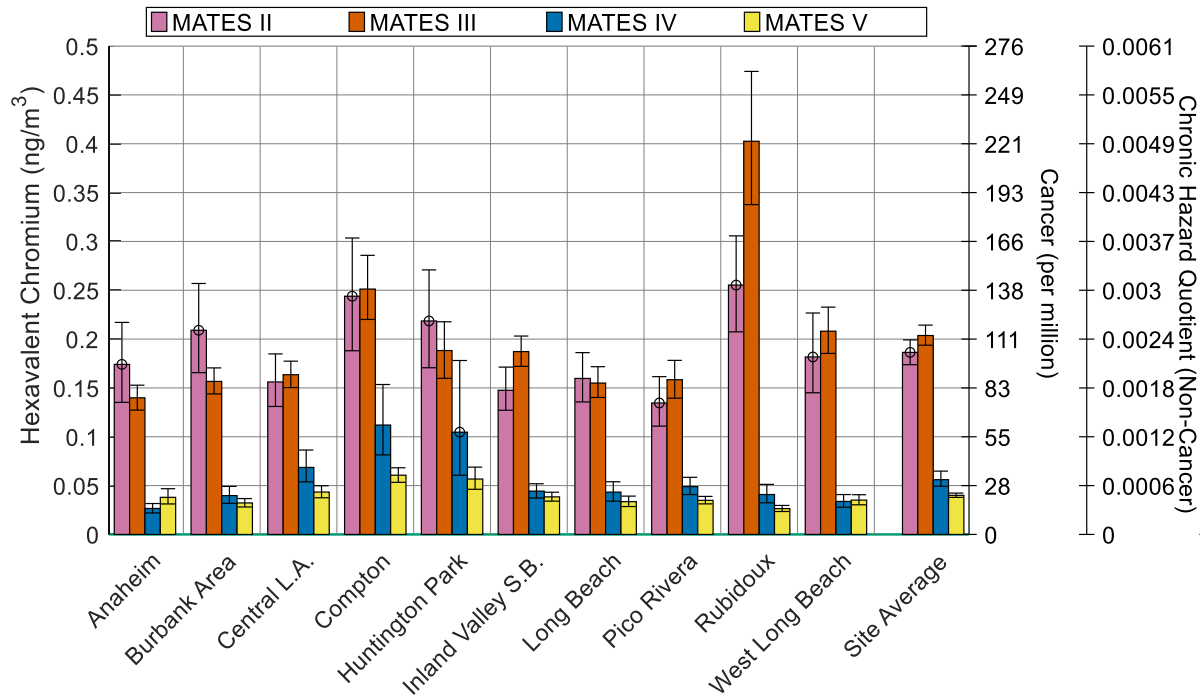


Figure 2-30. Average Concentrations of TSP Hexavalent Chromium. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. Error bars denote the 95% confidence interval.

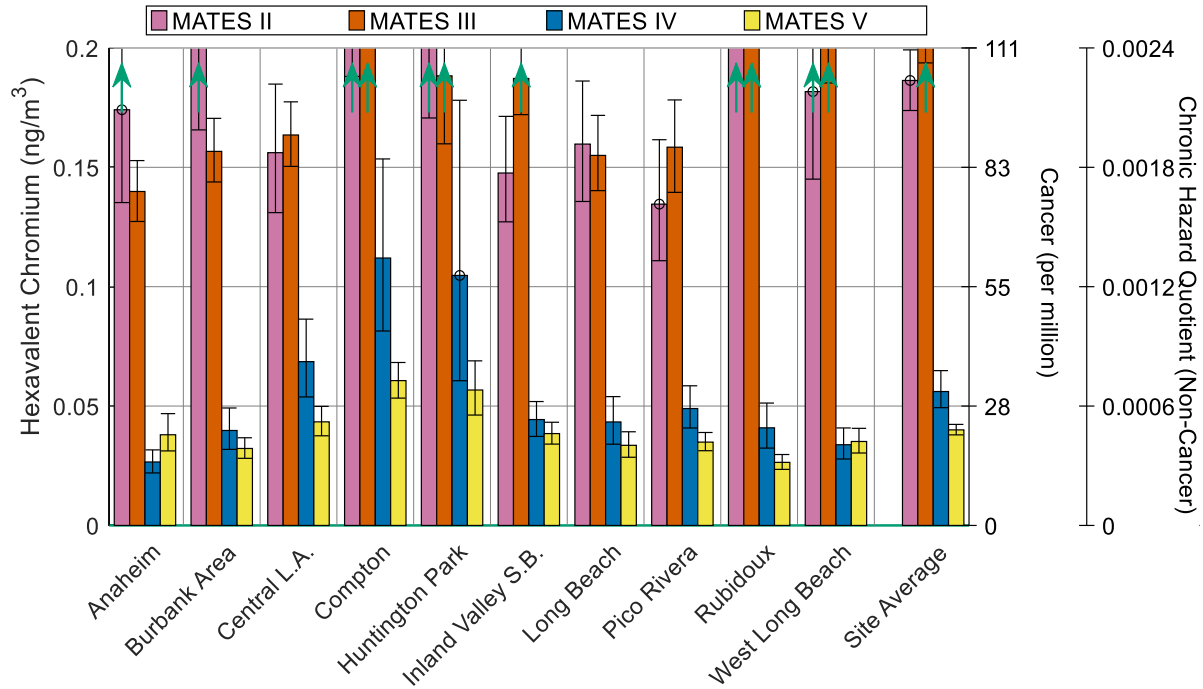


Figure 2-31. Average Concentrations of TSP Hexavalent Chromium. The upward arrows indicate that the data extends above the y-axis shown. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. Error bars denote the 95% confidence interval.

Concentrations of TSP Manganese are shown in Figure 2-32. TSP Manganese shows a decrease in concentration from MATES II to MATES V at Compton, Huntington Park, and Rubidoux. Anaheim and Pico Rivera both show decreases in TSP Manganese from MATES II to MATES IV followed by an increase in MATES V. Other stations show no significant trends.

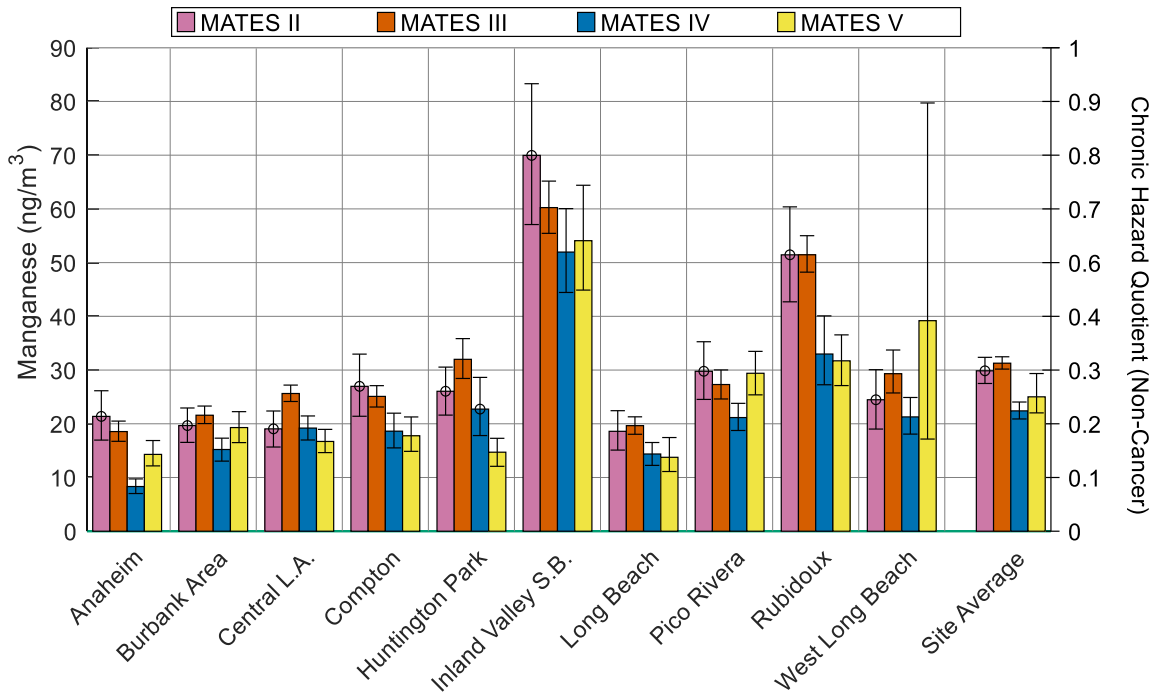


Figure 2-32. Average Concentrations of TSP Manganese. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. Error bars denote the 95% confidence interval.

Concentrations of TSP Beryllium are shown in Figure 2-33. TSP Beryllium was not measured during MATES II and MATES III. The shading on most of the bars in Figure 2-33 indicates that more than 80% of all measurements were below their MDLs at all stations in MATES IV and six out of ten stations in MATES V. Changes in the heights of the shaded bars indicate changes in the MDLs over time and do not provide information about the trends in concentration over time. The heights of the shaded bars provide upper bound estimates of the average annual concentrations.

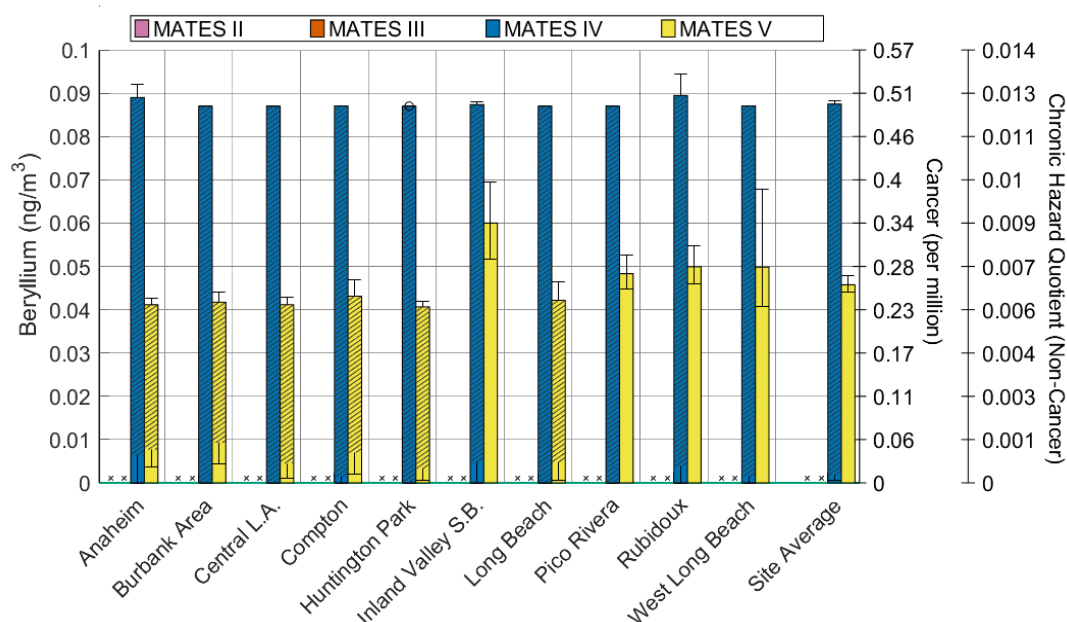


Figure 2-33. Average Concentrations of Beryllium. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “x” in the place of a bar indicates that there are no data for a given station/MATES iteration. “o” at the top of a bar or in the location of a missing bar indicates that valid measurements do not exist for at least 75% of the sampling days in all quarters. Error bars denote the 95% confidence interval.

Concentrations of TSP Selenium are shown in Figure 2-34. The shading on a bar indicates that more than 80% of the data used to calculate that bar were below detection limit. Caution should be used when interpreting trends with shaded bars since the height of shaded bars represent upper bound estimates using MDL substitution for data below the detection limit. However, since the KM mean was calculated for the MATES II data for all stations except Rubidoux and the upper bound estimates of the MATES V data or KM means are substantially lower than the MATES II KM means, we conclude that there has been a substantial decline in TSP Selenium from MATES II to MATES V at those stations. At Rubidoux, the KM mean for MATES IV is higher than the upper bound estimate for MATES V, which indicates that Rubidoux also has a decreasing trend.

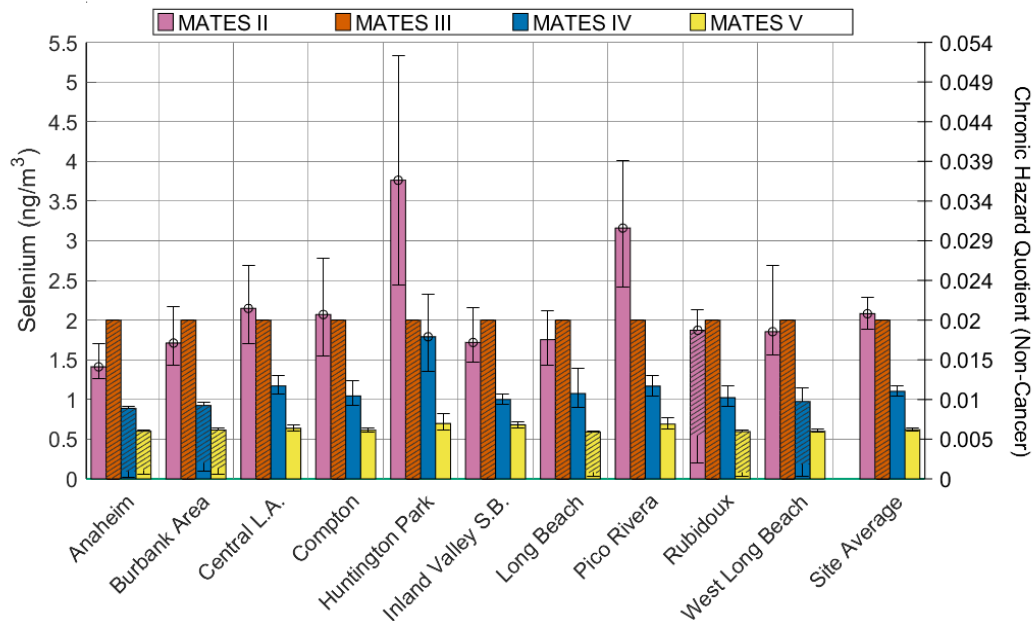


Figure 2-34. Average Concentrations of TSP Selenium. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. Error bars denote the 95% confidence interval.

Concentrations of PM_{2.5} chlorine are shown in Figure 2-35. PM_{2.5} chlorine was not measured in MATES II and MATES III. PM_{2.5} chlorine shows a decrease in concentrations from MATES IV to MATES V at Pico Rivera and West Long Beach, with insignificant changes at other sites.

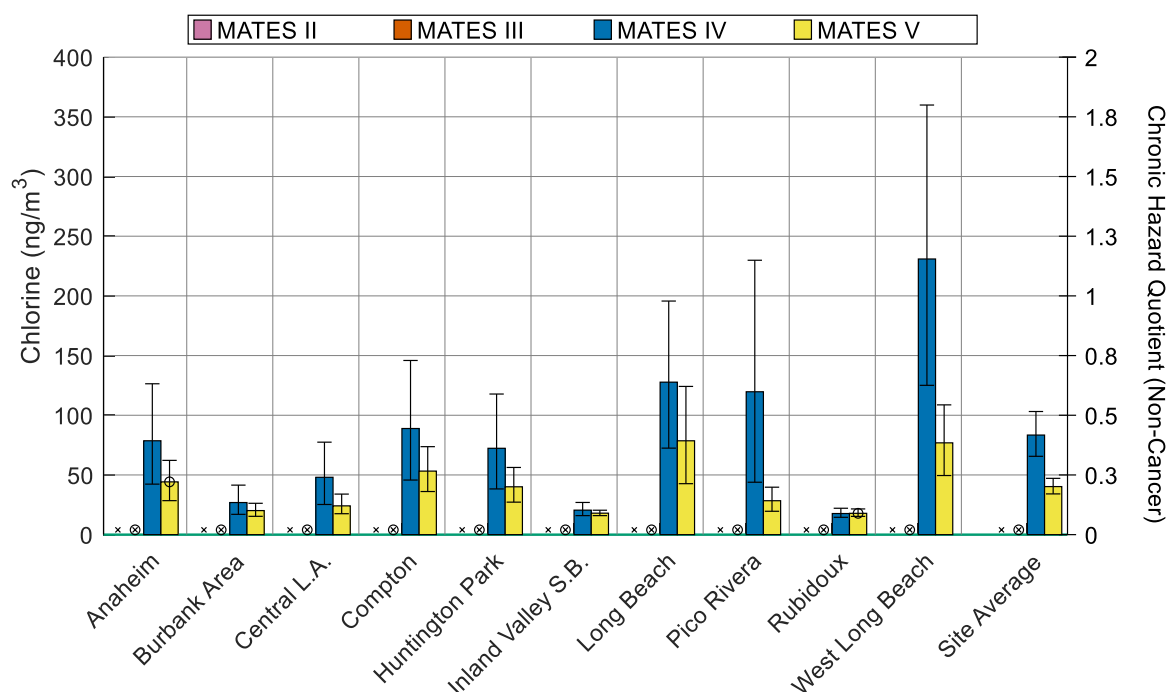


Figure 2-35. Average Concentrations of PM_{2.5} Chlorine. “x” in the place of a bar indicates that there are no data for a given station/MATES iteration. “o” at the top of a bar or in the location of a missing bar indicates that valid measurements do not exist for at least 75% of the sampling days in all quarters. Error bars denote the 95% confidence interval.

Naphthalene and Other PAH Compounds

Measurements of naphthalene and several other PAHs (polycyclic aromatic hydrocarbons) were taken at some sites, as shown in the figures below. These substances are regularly monitored on a one in six day basis under the federal NATTS program for Central LA and Rubidoux. PAHs are mainly formed from the incomplete combustion of organic materials.

Concentrations of Naphthalene are shown in Figure 0-36. Concentrations of Naphthalene decreased significantly from MATES IV to V at Central L.A. and Rubidoux.

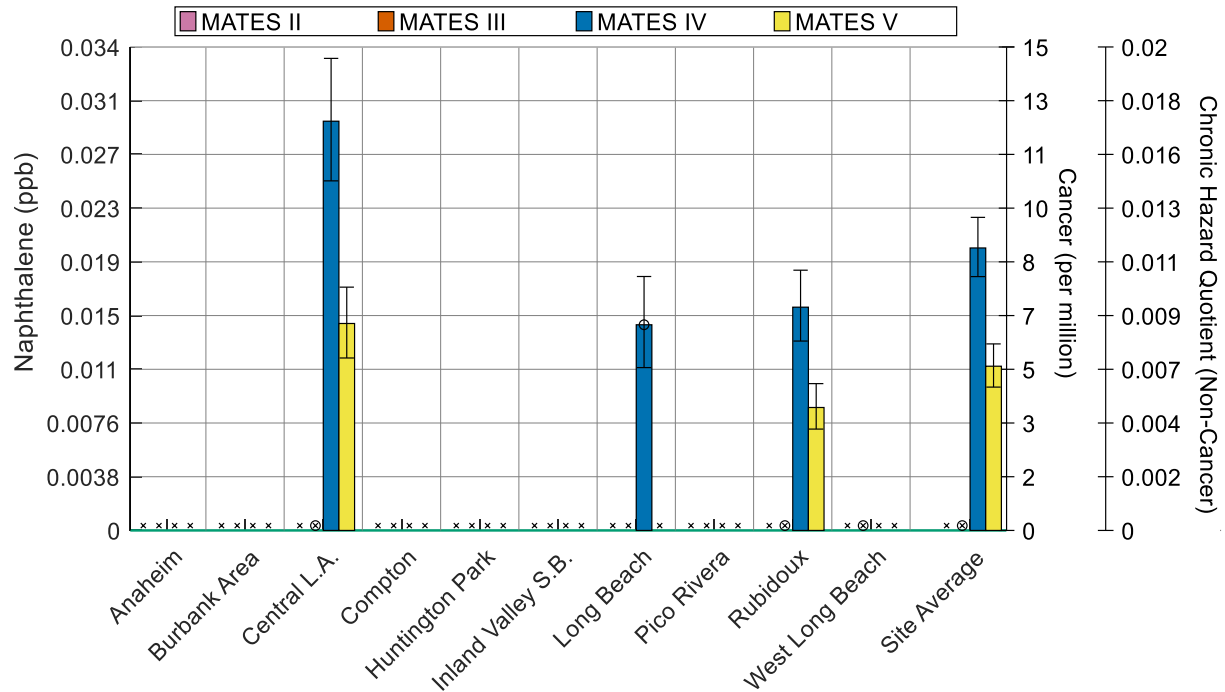


Figure 0-36. Average Annual Concentrations of Naphthalene. “x” in the place of a bar indicates that there are no data for a given station/MATES iteration. “o” at the top of a bar or in the location of a missing bar indicates that valid measurements do not exist for at least 75% of the sampling days in all quarters. Error bars denote the 95% confidence interval.

Concentrations of Benzo(a)pyrene are shown in Figure 0-37. Concentrations of Benzo(a)pyrene are significantly lower at Central L.A. in MATES V compared to MATES II.

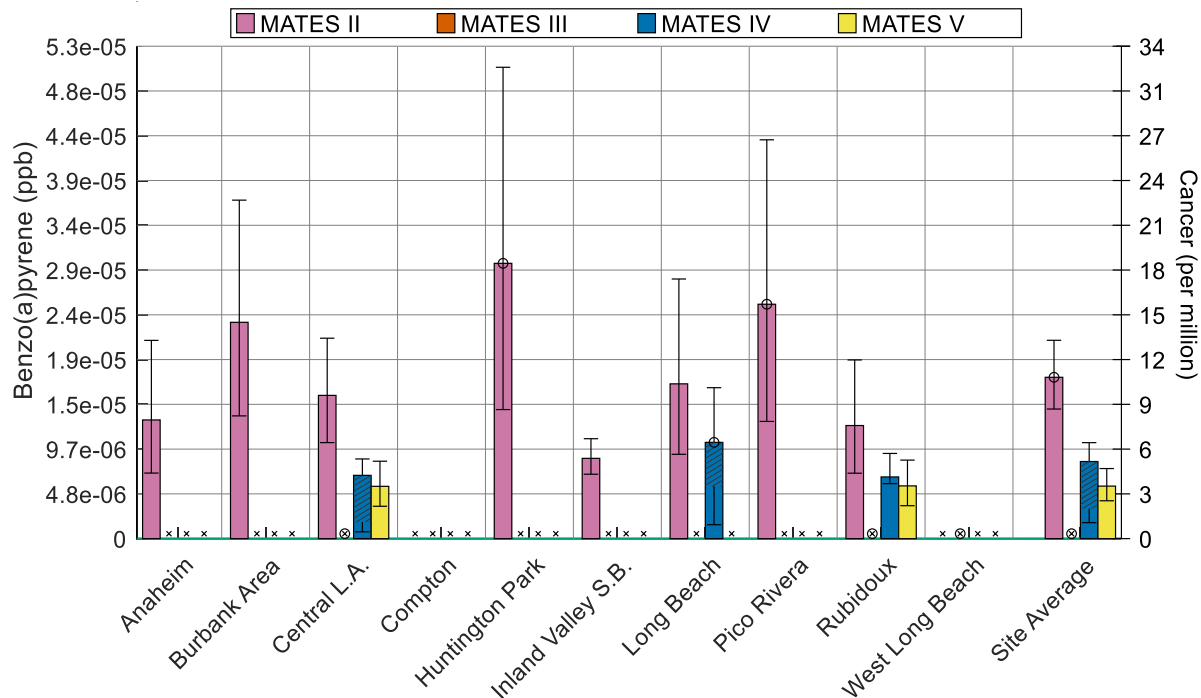


Figure 0-37. Average Concentrations of Benzo(a)pyrene. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “x” in the place of a bar indicates that there are no data for a given station/MATES iteration. “o” at the top of a bar or in the location of a missing bar indicates that valid measurements do not exist for at least 75% of the sampling days in all quarters. Error bars denote the 95% confidence interval.

Concentrations of Benzo(b)fluoranthene are shown in Figure 0-38. Concentrations of Benzo(b)fluoranthene do not show significant trends over time (i.e., the error bars representing the 95% confidence interval overlap).

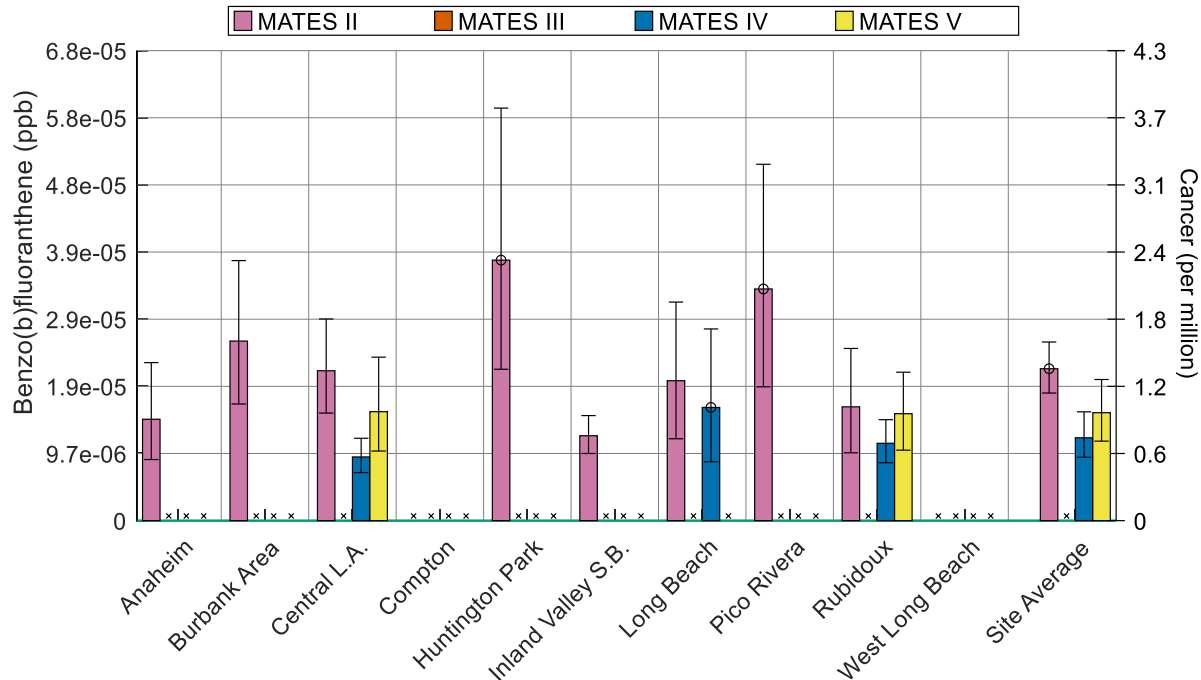


Figure 0-38. Average Concentrations of Benzo(b)fluoranthene. “x” in the place of a bar indicates that there are no data for a given station/MATES iteration. “o” at the top of a bar or in the location of a missing bar indicates that valid measurements do not exist for at least 75% of the sampling days in all quarters. “o” indicates that valid measurements do not exist for at least 75% of the sampling days in each quarter. Error bars denote the 95% confidence interval.

Concentrations of Benzo(k)fluoranthene are shown in Figure 0-39. Concentrations of Benzo(a)pyrene are significantly lower at Central L.A. in MATES V compared to MATES II. Concentrations do not show significant trends over time in Rubidoux as the error bars representing the 95% confidence interval overlap. “x” indicates that data is unavailable for a given station/MATES iteration.

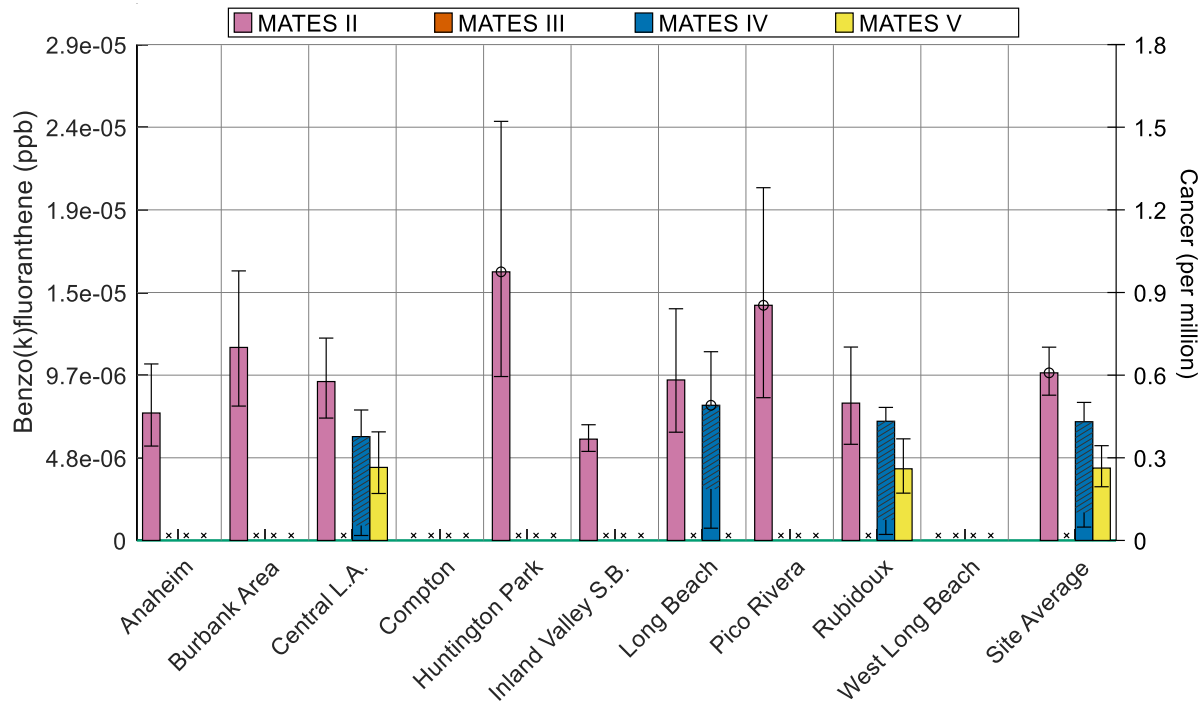


Figure 0-39. Average Concentrations of Benzo(k)fluoranthene. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “x” in the place of a bar indicates that there are no data for a given station/MATES iteration. “o” at the top of a bar or in the location of a missing bar indicates that valid measurements do not exist for at least 75% of the sampling days in all quarters. Error bars denote the 95% confidence interval.

Concentrations of Dibenz(a,h)anthracene are shown in Figure 0-40. The shading on a bar indicates that 80% of the data were below their MDL. This means that the height of the bars over time are primarily reflective of MDLs, and trends in concentrations over time cannot be determined from these data. The shaded bars do provide lower and upper bound estimates of average annual concentrations.

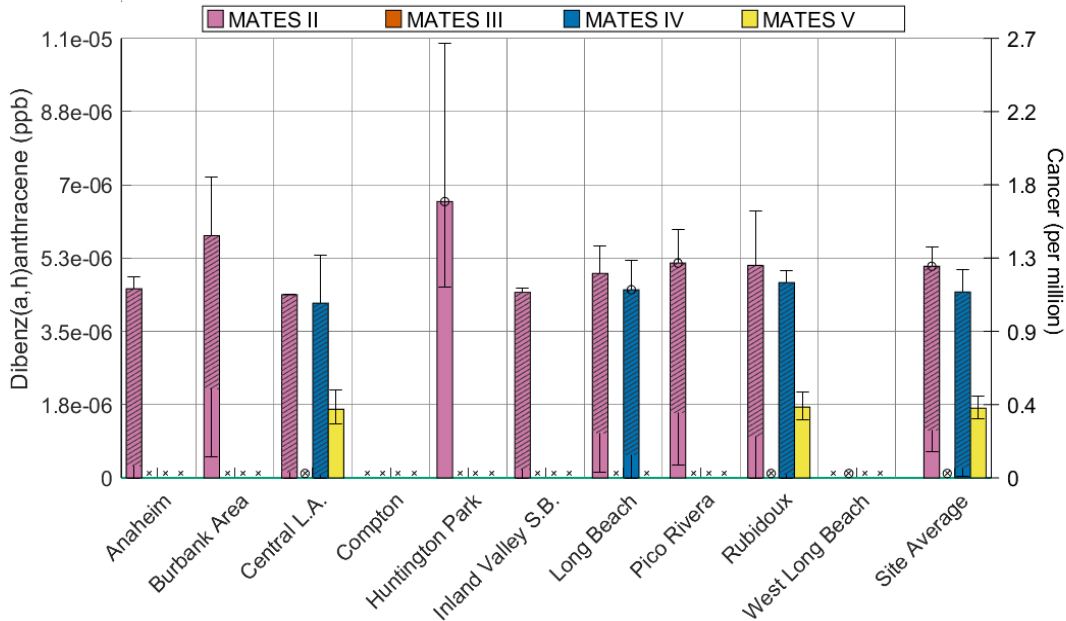


Figure 0-40. Average Concentrations of Dibenz(a,h)anthracene. The diagonal lines (shading) on the bars indicate that more than 80% of the measurements for those stations were below the method detection limits (MDLs). The lower edge of the shading shows the mean with zero substituted for all measurements below the MDL. The upper edge of the shading shows the mean with the MDL substituted for all measurements below the MDL. All other averages are calculated using the KM mean. “x” in the place of a bar indicates that there are no data for a given station/MATES iteration. “o” at the top of a bar or in the location of a missing bar indicates that valid measurements do not exist for at least 75% of the sampling days in all quarters. Error bars denote the 95% confidence interval.

Concentrations of indeno(1,2,3-c,d)pyrene are shown in Figure 0-41. Concentrations of indeno(1,2,3-c,d)pyrene are significantly lower during MATES IV and MATES V compared to MATES II at Central L.A. and Rubidoux, with insignificant changes between MATES IV and MATES V.

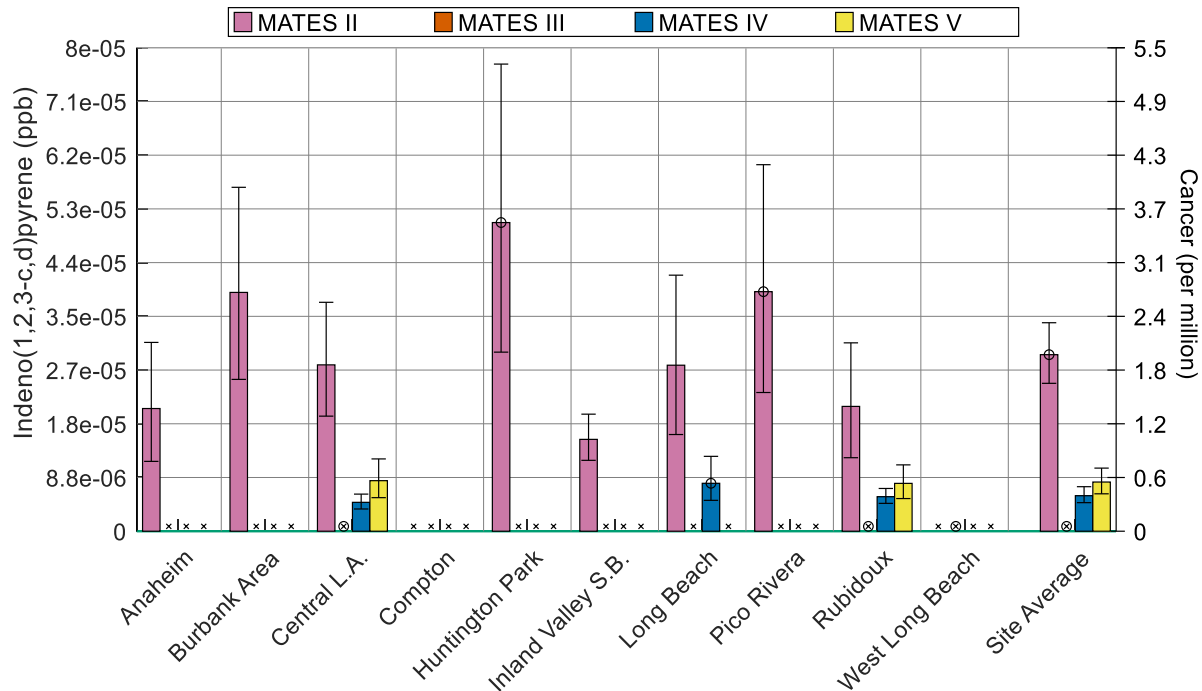


Figure 0-41. Average Concentrations of Indeno(1,2,3-c,d)pyrene. “x” in the place of a bar indicates that there are no data for a given station/MATES iteration. “o” at the top of a bar or in the location of a missing bar indicates that valid measurements do not exist for at least 75% of the sampling days in all quarters. Error bars denote the 95% confidence interval.

Concentrations of benzo(a)anthracene are shown in Figure 0-42. Concentrations of benzo(a)anthracene show insignificant trending over time (i.e., the error bars representing the 95% confidence interval overlap).

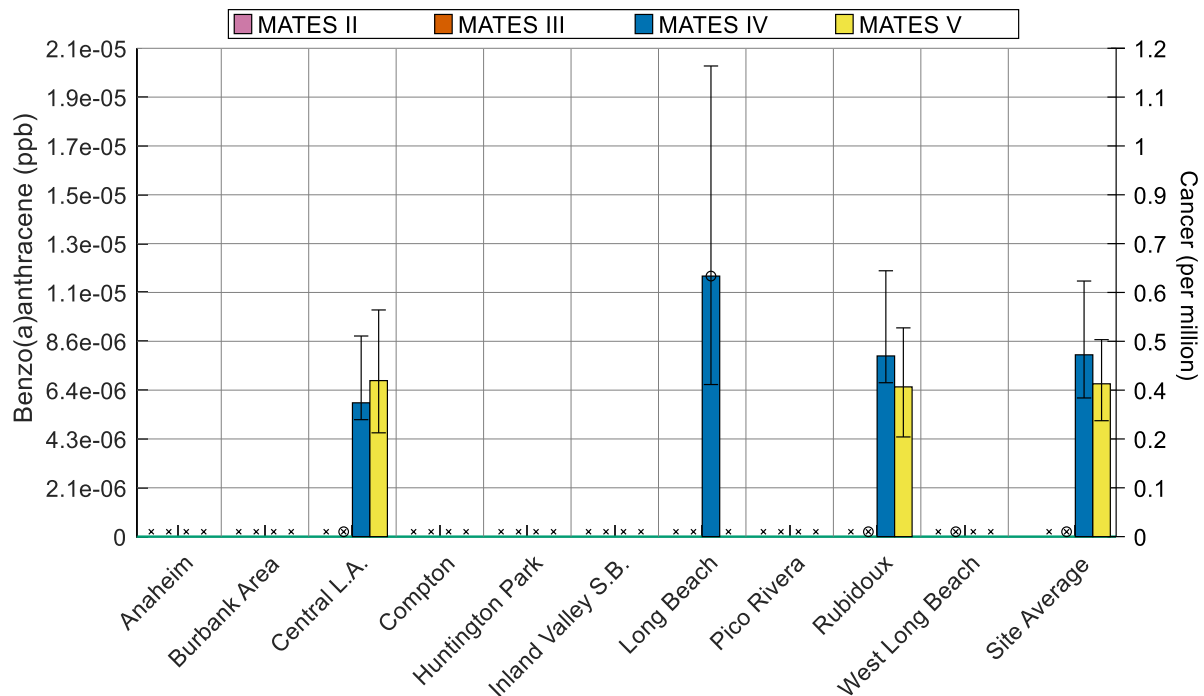


Figure 0-42. Average Concentrations of Benzo(a)anthracene. “x” in the place of a bar indicates that there are no data for a given station/MATES iteration. “o” at the top of a bar or in the location of a missing bar indicates that valid measurements do not exist for at least 75% of the sampling days in all quarters. Error bars denote the 95% confidence interval.

Concentrations of chrysene are shown in Figure 0-43. Concentrations of chrysene show insignificant trending over time (i.e., the error bars representing the 95% confidence interval overlap).

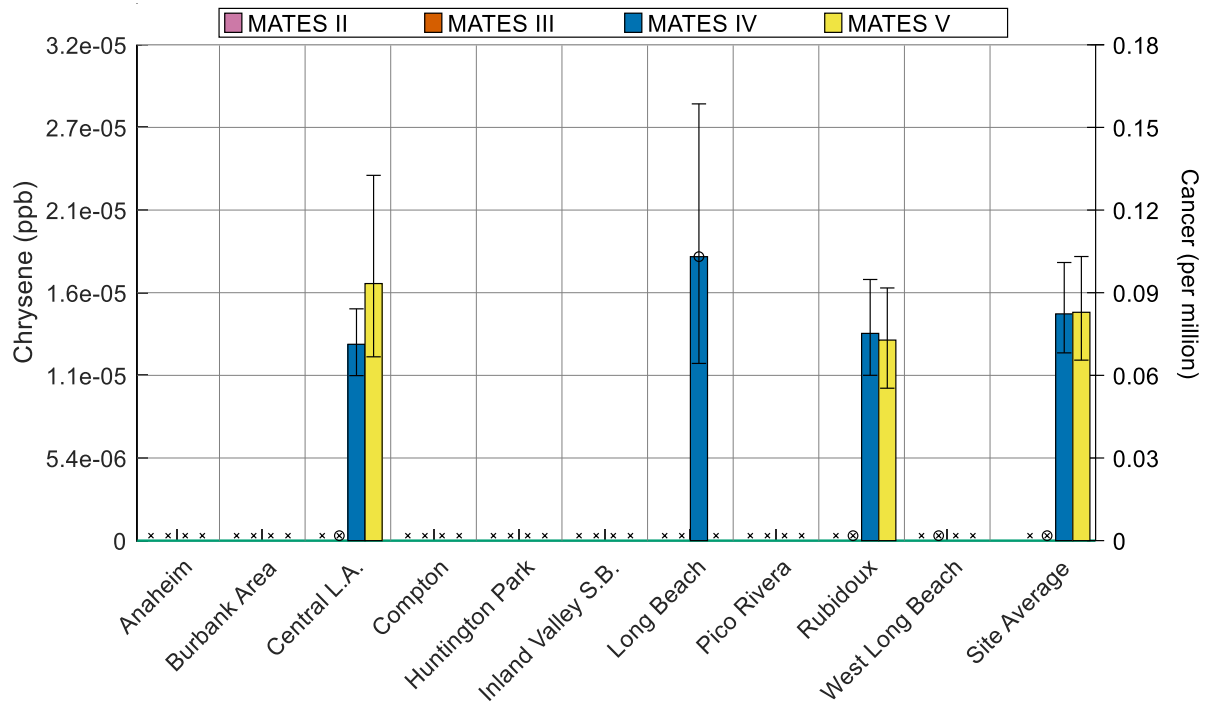


Figure 0-43. Average Concentrations of Chrysene. “x” in the place of a bar indicates that there are no data for a given station/MATES iteration. “o” at the top of a bar or in the location of a missing bar indicates that valid measurements do not exist for at least 75% of the sampling days in all quarters. Error bars denote the 95% confidence interval.

MATES V Estimates of Cancer Risk based on Monitoring Data

Figure 0-44 shows the estimated cancer risks for the toxics measured at each site for the MATES V Study. Since cumulative risks would be artificially low if any analytes were not measured, substitutions were imputed (mostly using the basin average). Several data substitution methods were explored—all of which resulted in similar conclusions. Further descriptions of the data substitution method and a comparison to other methods can be found in Appendix IV. Bar segments that have larger uncertainty, either because the data were substituted or because more than 80% of the measurements were below detection limit, are marked with gray dots. See Appendix XI for statistical methods. Figure 0-46 shows the same data as Figure 0-45, with analytes grouped together. The same grouping is used for the pie chart in Figure 0-46 showing the fraction of cancer risk due to each pollutant category, based on basin-wide average concentrations.

As discussed in this chapter, most of the measurements at Anaheim for VOC and Carbonyl species were invalidated. The basin-wide average concentration was used to fill in the missing Anaheim data. This additional uncertainty for the Anaheim data is represented in the aggregate risk plots by the shading with gray dots. In MATES V, diesel exhaust is the largest contributor to the cancer risk for all stations, contributing approximately 50% of the cancer risk. Benzene, 1,3-Butadiene, and Carbonyls make up approximately 25% of the cancer risk.

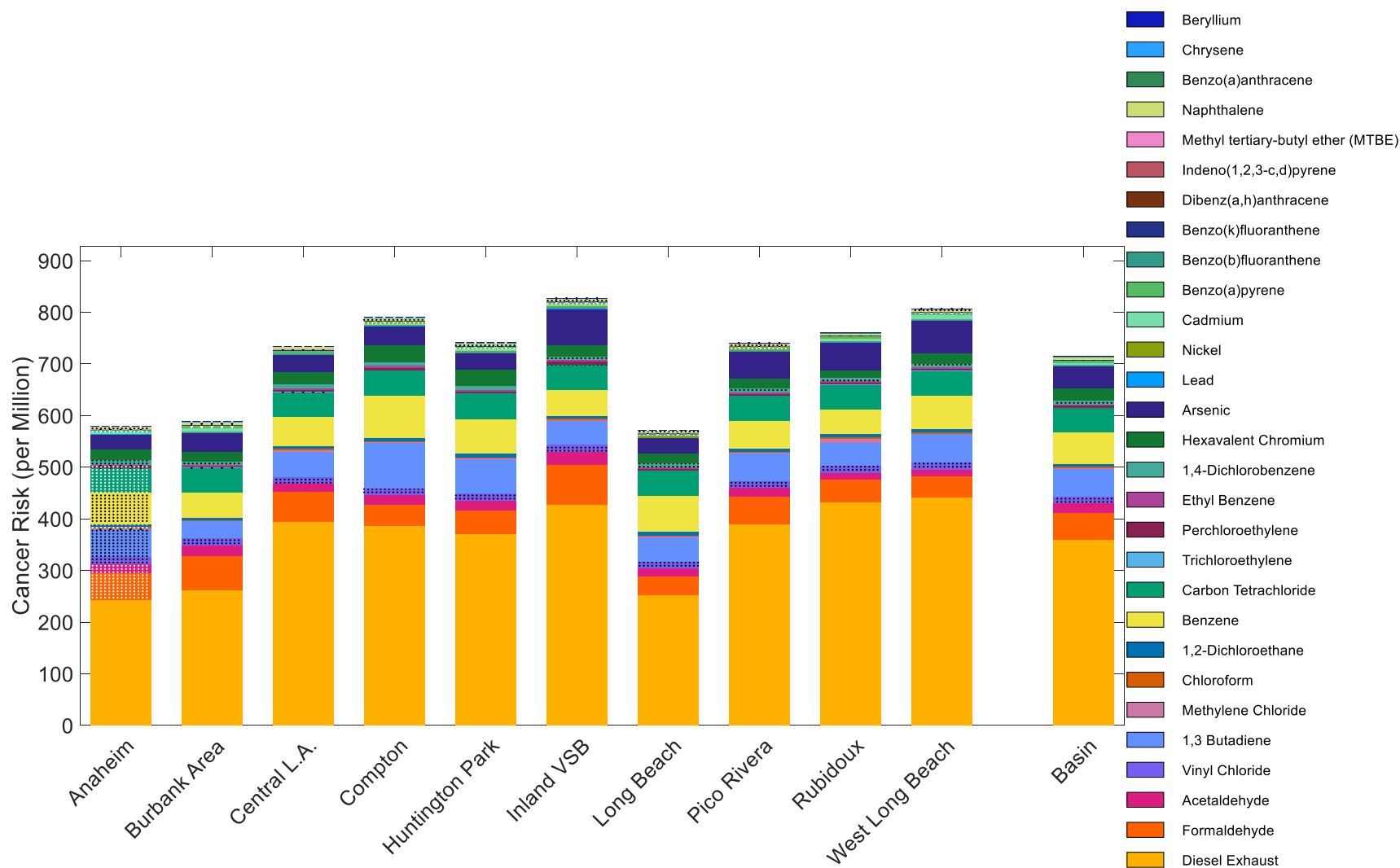


Figure 0-44. Bar charts of the cumulative cancer risks by station for MATES V. 1,2 Dibromoethane is excluded because of high uncertainty due to all measurements being below detection limit for each station. Gray dots are used to mark bar segments that are more uncertain due to either substitution for data that were unavailable or data for which more than 80% of measurements were below detection limit.

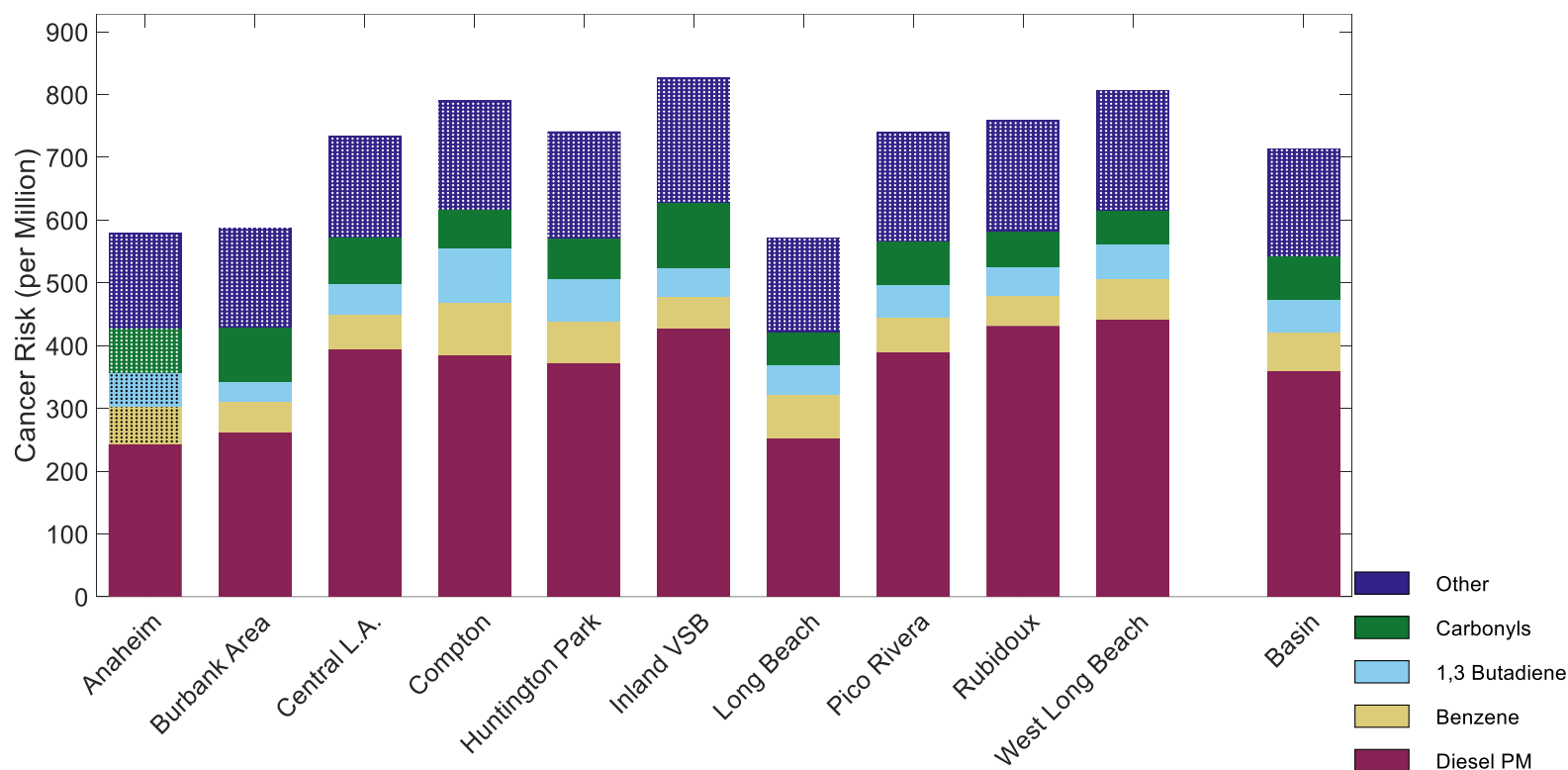


Figure 0-45. Bar charts of the cumulative cancer risks by station for MATES V with grouped analytes. 1,2 Dibromoethane is excluded because of high uncertainty due to all measurements being below detection limit for each station. Gray dots are used to mark bar segments that are more uncertain due to either substitution for data that were unavailable or data for which more than 80% of measurements were below detection limit.

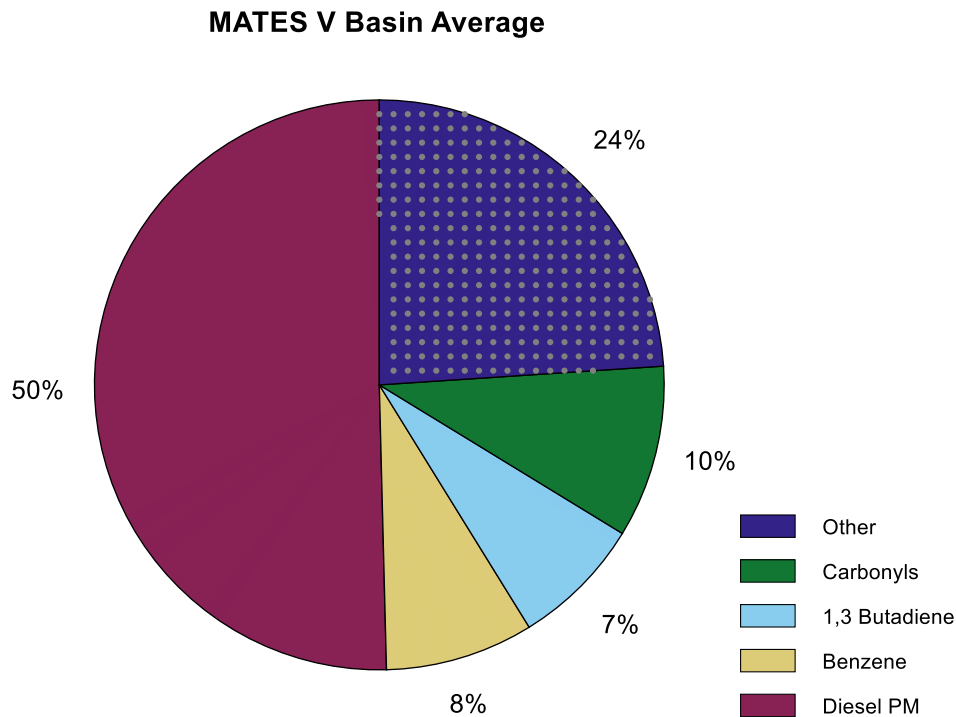


Figure 0-46. Pie charts of the basin-wide cumulative cancer risks for MATES V. 1,2 Dibromoethane is excluded because of high uncertainty due to all measurements being below detection limit for each station. Gray dots are used to mark segments that are more uncertain due to either substitution for data that were unavailable or data for which more than 80% of measurements were below detection limit.

Cancer Risk Trends based on Monitoring Data

Figure 0-47 shows the estimated cancer risk trends for the toxics measured at each site for MATES II through MATES V. Since cumulative risks would be artificially low if any analytes are missing, substitutions were imputed (mostly using the basin average). Several data substitution methods were explored—all of which resulted in similar conclusions. Further descriptions of the data substitution method and a comparison to other methods can be found in Appendix IV. Bar segments that have larger uncertainty, either because the data were substituted or because more than 80% of the measurements were below detection limit are marked with gray dots. See Appendix XI for statistical methods.

Figure 0-48 shows the same data as Figure 0-47, with analytes grouped together. The same grouping is used for the pie charts in Figure 0-49 showing the fraction of risk due to each pollutant category, based on basin-wide average concentrations for MATES II through MATES V.

Cancer risk declined substantially from MATES III to MATES IV, with continued, albeit smaller, progress from MATES IV to MATES V. As can be seen in Figure 0-48, all categories of pollutants have shown declines in concentration and therefore cancer risk. Cancer risk from

diesel exhaust has declined more quickly than the other pollutant categories. Diesel exhaust was responsible for approximately 63-74% of the cancer risk for MATES II through MATES IV. In MATES V, however, diesel exhaust accounts for approximately 50% of the cancer risk, see Figure 0-49.

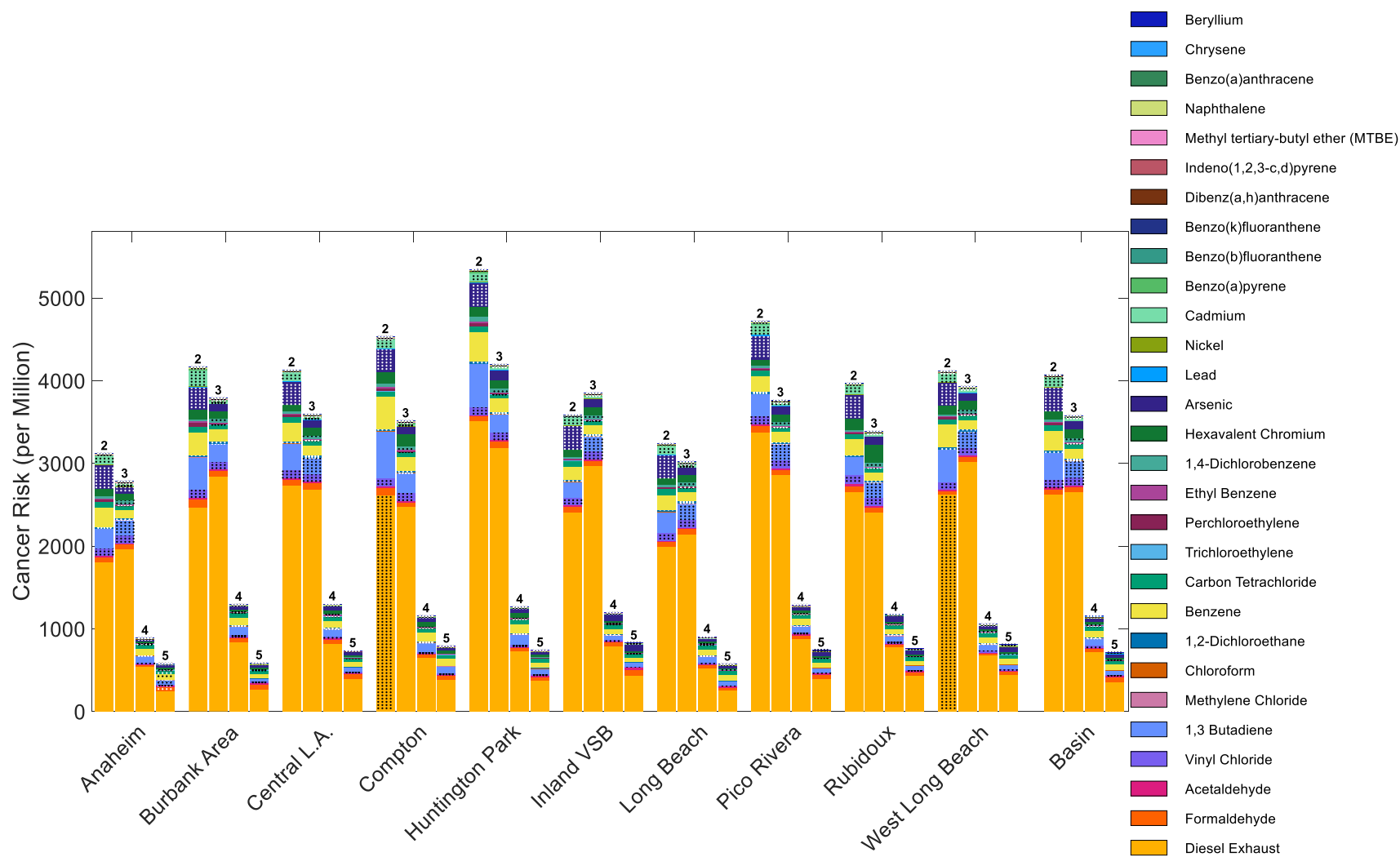


Figure 0-47. Cancer risk trends across MATES II through MATES V at all stations. 1,2 Dibromoethane is excluded because of high uncertainty due to all measurements being below the detection limit for each station for all MATES projects. Bromomethane was also excluded because it was only measured in MATES V and trends cannot be inferred. Gray dots are used to mark bar segments that are more uncertain due to either substitution for data that were unavailable or data for which more than 80% of measurements were below detection limit.

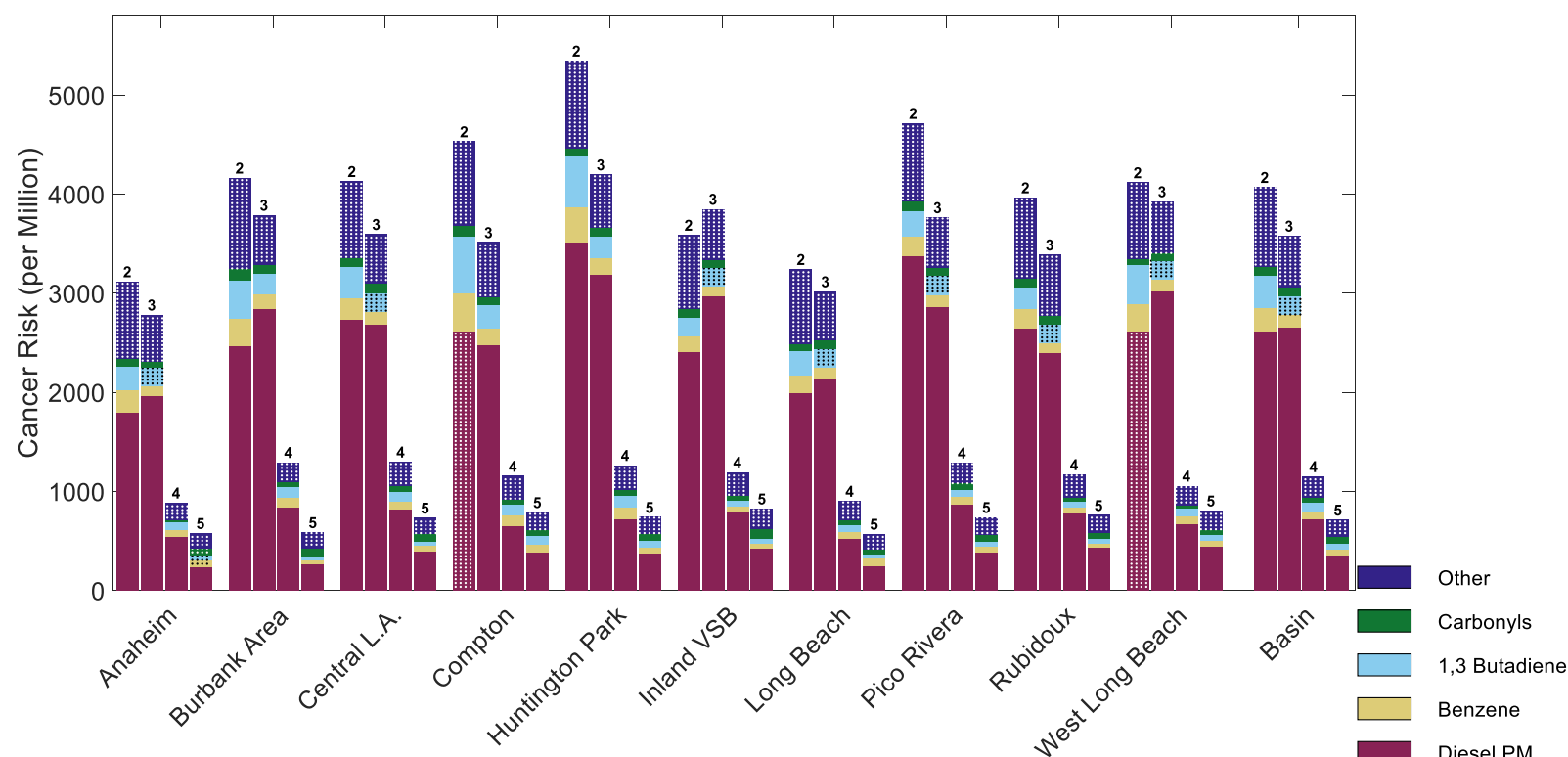


Figure 0-48. Cancer risk trends across MATES II through MATES V at all stations with analytes grouped. 1,2 Dibromoethane is excluded because of high uncertainty due to all measurements being below the detection limit for each station for all MATES projects. Gray dots are used to mark bar segments that are more uncertain due to either substitution for data that were unavailable or data for which more than 80% of measurements were below detection limit.

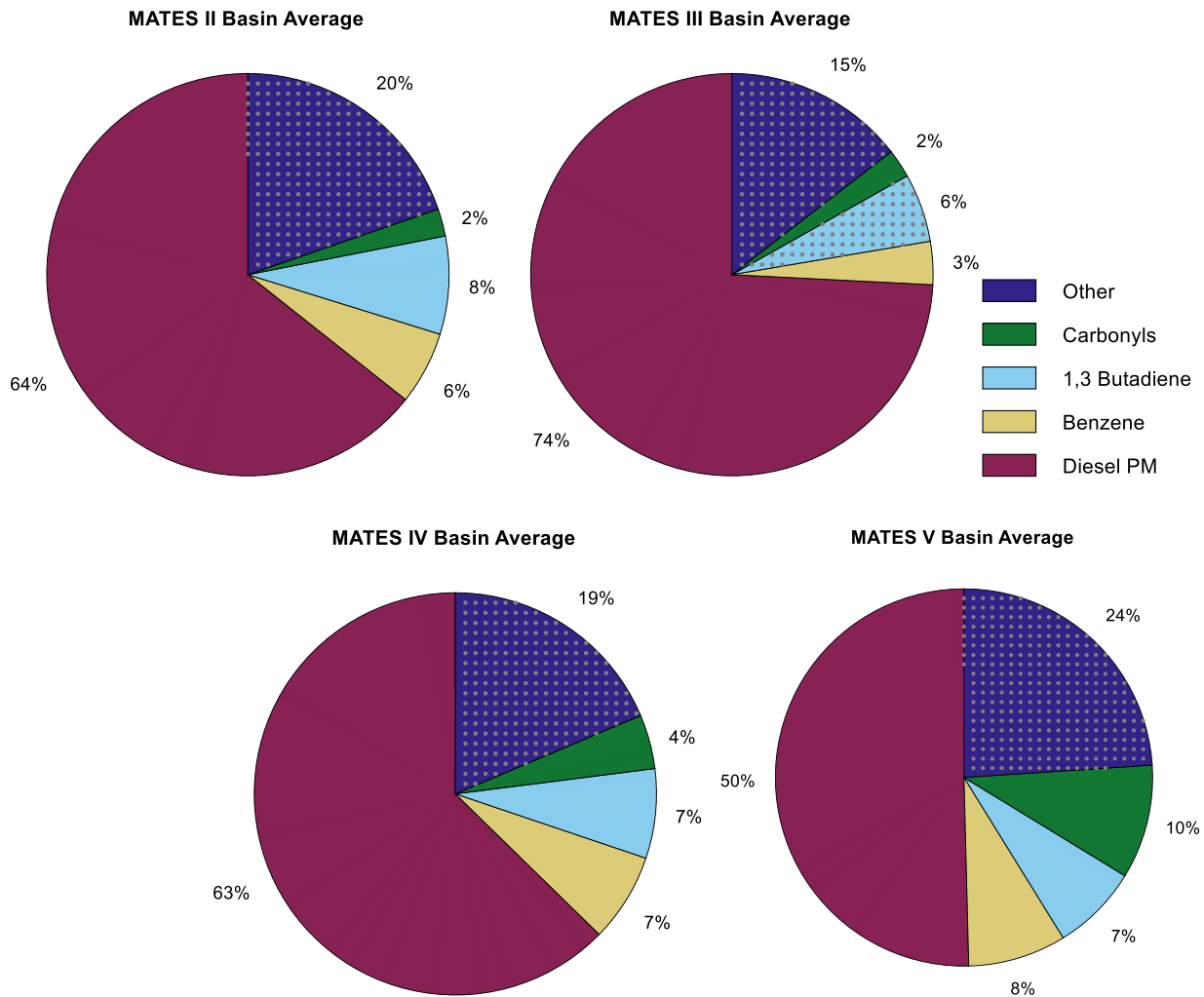


Figure 0-49. Pie charts of the basin-wide cumulative cancer risks for MATES II through MATES V. 1,2 Dibromoethane is excluded because of high uncertainty due to all measurements being below the detection limit for each station for all MATES projects. Gray dots are used to mark bar segments that are more uncertain due to either substitution for data that were unavailable or data for which more than 80% of measurements were below detection limit.

MATES V Estimates of Chronic Non-Cancer Risk based on Monitoring Data

Figure 0-51 shows the estimated chronic risks for the toxics measured at each site for the MATES V Study. Since cumulative risks would be artificially low if any analytes are missing, substitutions were imputed (mostly using the basin average). Several data substitution methods were explored—all of which resulted in similar conclusions. Further descriptions of the data substitution method and a comparison to other methods can be found in Appendix IV. Bar segments that have larger uncertainty, either because the data were substituted or because more than 80% of the measurements were below detection limit are marked with gray dots. See Appendix XI for statistical methods.

Figure 0-52 shows the same data as Figure 0-51, with analytes grouped together. The same grouping is used for the pie chart in Figure 0-52 showing the fraction of chronic risk due to each pollutant category, based on basin-wide average concentrations.

Chronic non-cancer risk is primarily driven by arsenic, which accounts for approximately 50% of the overall chronic non-cancer risk. Chronic non-cancer risk from arsenic is driven equally by the following target organ systems: cardiovascular system, nervous system, reproductive/developmental, respiratory, and skin. Based on the monitoring data, acrolein (2-Propenal) accounts for approximately 22% of the chronic risk, driven by the impacts on the respiratory system, although there is substantial uncertainty associated with the measurement method, and no alternative method has been published.¹² Formaldehyde and benzene account for approximately 6% and 5% of the chronic risk, respectively. The chronic non-cancer risk for formaldehyde is driven by the impacts on the respiratory system, while the risk for benzene is driven by the hematologic system. Other species are responsible for the remainder of the risk.

The TSP arsenic concentrations from MATES V are consistent with those measured at most of the 79 sites in 13 states around the U.S. in the Ambient Monitoring Archive (AMA) for 2017 (<https://www3.epa.gov/ttn/amtic/toxdat.html#data>). South Coast AQMD staff analyzed the 2017 AMA data using the same methods used for the MATES data (see Appendix XI). One site in Pennsylvania has a 95% confidence interval entirely lower than the 95% confidence intervals observed for the SoCAB for MATES V. One site near Bakersfield, CA and three sites in Ohio have 95% confidence intervals that are entirely above the 95% confidence intervals seen in MATES V. All other sites in the AMA data have 95% confidence intervals that overlap with those of MATES V.

A chronic non-cancer hazard index that is less than one indicates that the air toxics levels are not expected to cause such health effects. A hazard index greater than one does not mean that such health effects are expected, but rather that there is some risk of experiencing chronic non-cancer health effects from that pollution. The larger the hazard index, the greater the risk of experiencing those health effects in the exposed population.

Based on the MATES V monitoring data, the estimated chronic non-cancer hazard indices range from about 5 to 9. Five stations (Burbank Area, Central LA, Compton, Huntington Park, and

¹² <https://ww2.arb.ca.gov/acrolein-test-method-advisory-and-data>

Long Beach) had chronic hazard indices between 5 and 6. The estimated chronic hazard indices for Pico Rivera and Rubidoux stations were approximately 7. West Long Beach and Inland Valley San Bernardino stations had the highest chronic hazard indices of between 8 and 9. There was substantial missing data at the Anaheim station, but the best estimate of the chronic hazard index in this location is approximately 5. Given the uncertainty in the measurement accuracy of acrolein, however, these estimates should not be interpreted as precise risk numbers, but rather provide a measure of comparative risk across the different locations.

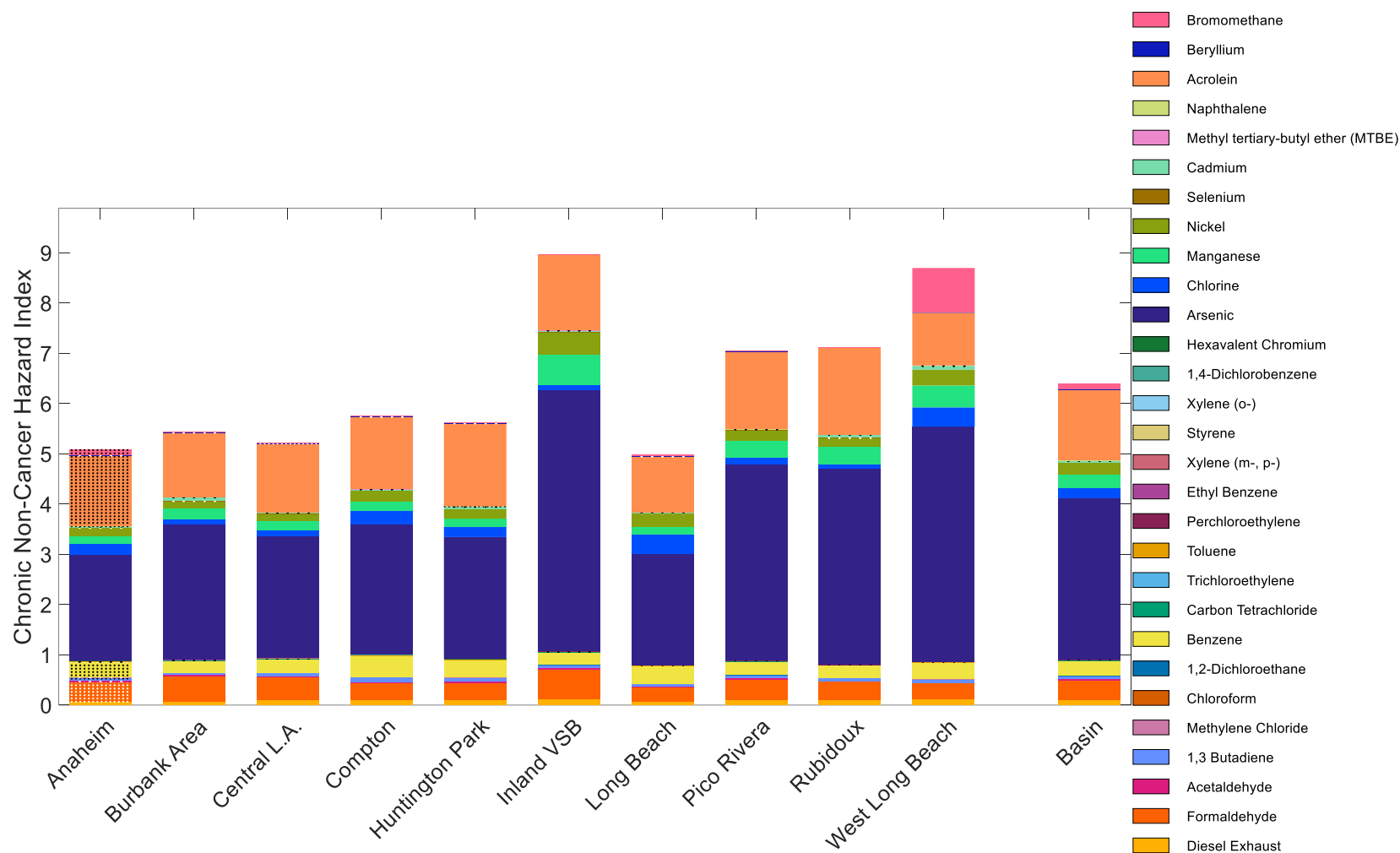


Figure 0-50. Bar charts of the cumulative chronic non-cancer risks by station for MATES V. 1,2 Dibromoethane is excluded because of high uncertainty due to all measurements being below detection limit for each station. Gray dots are used to mark bar segments that are more uncertain due to either substitution for data that were unavailable or data for which more than 80% of measurements were below detection limit.

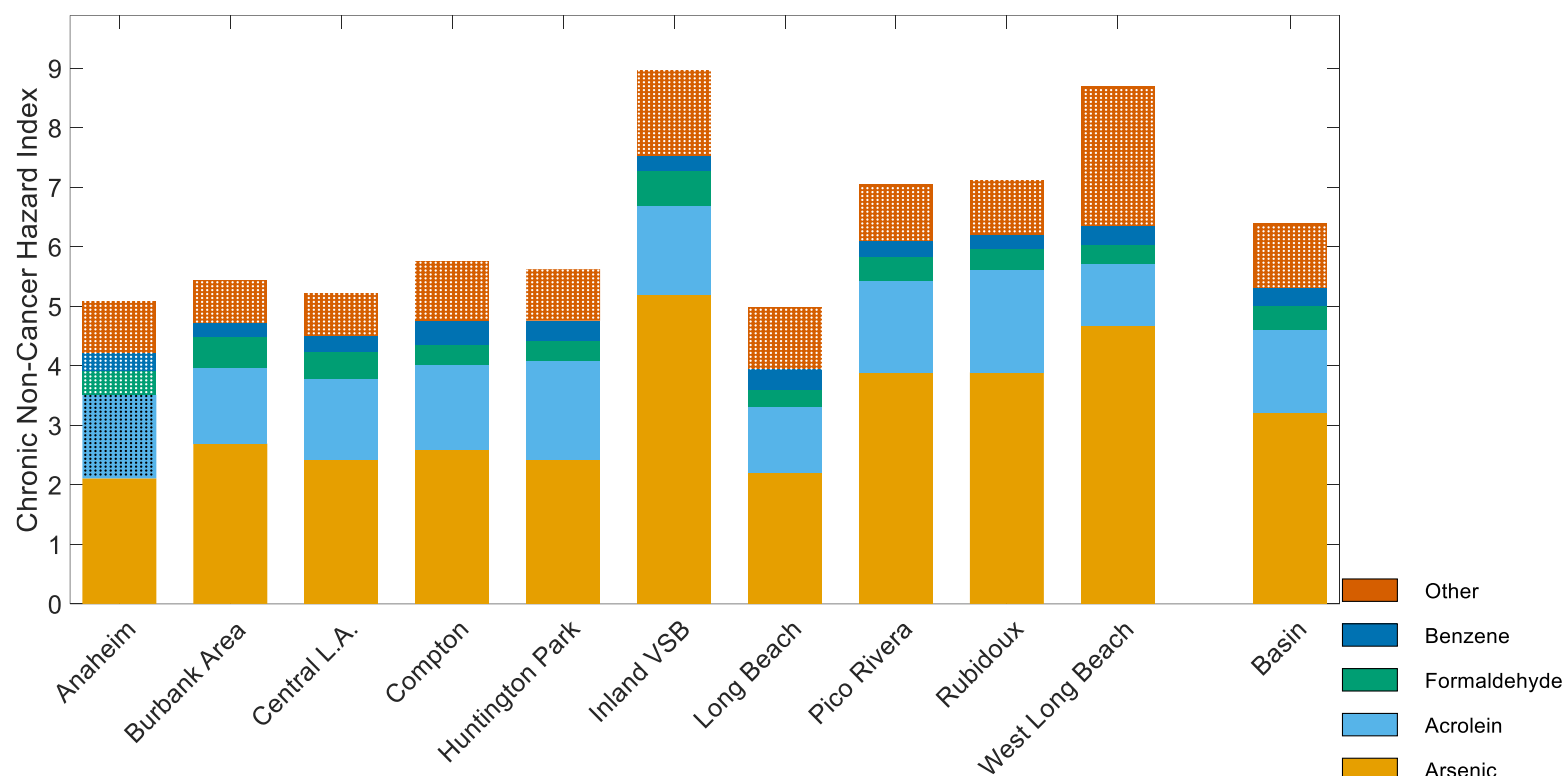


Figure 0-51. Bar charts of the cumulative chronic non-cancer risks by station for MATES V with grouped analytes. 1,2
 Dibromoethane is excluded because of high uncertainty due to all measurements being below detection limit for each station. Gray dots are used to mark bar segments that are more uncertain due to either substitution for data that were unavailable or data for which more than 80% of measurements were below detection limit.

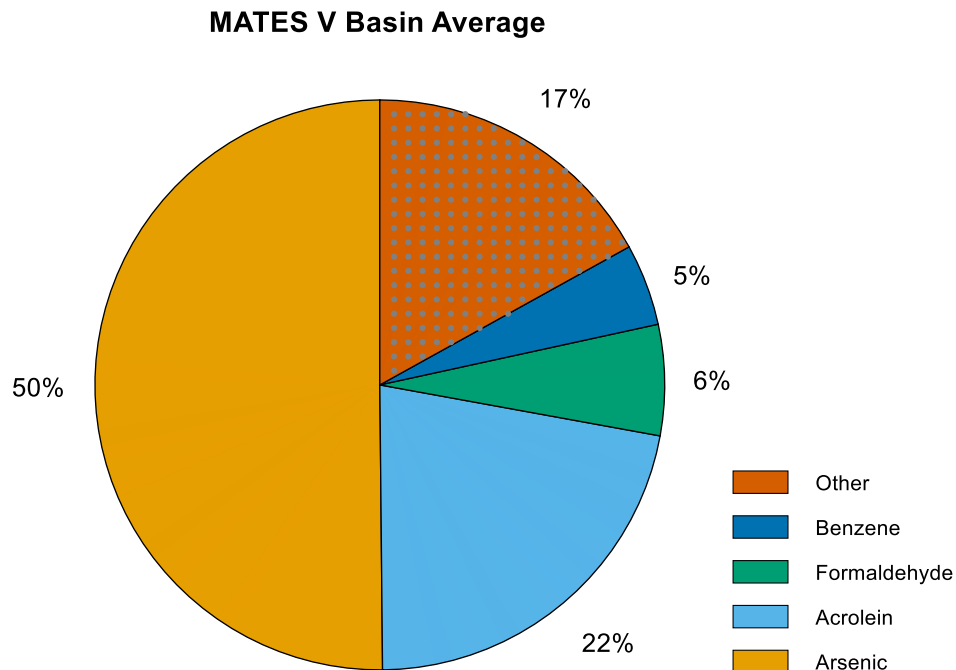


Figure 0-52. Pie charts of the basin-wide cumulative chronic risks for MATES V. 1,2 Dibromoethane is excluded because of high uncertainty due to all measurements being below detection limit for each station. Gray dots are used to mark segments that are more uncertain due to either substitution for data that were unavailable or data for which more than 80% of measurements were below detection limit. Note that this figure is slightly different from the MATES V pie chart shown in Figure 0-55 since Bromomethane is excluded from Figure 0-55.

Chronic Non-Cancer Risk Trends based on Monitoring Data

Figure 0-53 shows the estimated chronic non-cancer risk trends for the toxics measured at each site for MATES III through MATES V. Since cumulative risks would be artificially low if any analytes are missing, substitutions were imputed (mostly using the basin average). Several data substitution methods were explored—all of which resulted in similar conclusions. Further descriptions of the data substitution method and a comparison to other methods can be found in Appendix IV. Bar segments that have larger uncertainty, either because the data were substituted or because more than 80% of the measurements were below detection limit are marked with gray dots. See Appendix XI for statistical methods.

Figure 0-54 shows the same data as Figure 0-53, with analytes grouped together. The same grouping is used for the pie charts in Figure 0-55 showing the fraction of risk due to each pollutant category, based on basin-wide average concentrations for MATES III through MATES V.

Given that there is more uncertainty in the MATES II data for the pollutants that appear to drive the chronic non-cancer risk, it is difficult to draw conclusions about trends in this type of risk since MATES II. However, the data do support that chronic non-cancer risk declined

substantially from MATES III to MATES IV. Chronic non-cancer risk remained similar from MATES IV to MATES V, with some stations increasing slightly and some stations decreasing slightly. The fraction of the chronic risk due to arsenic declined from MATES III through MATES IV, decreasing from approximately 55% in MATES III to approximately 50% in MATES IV.

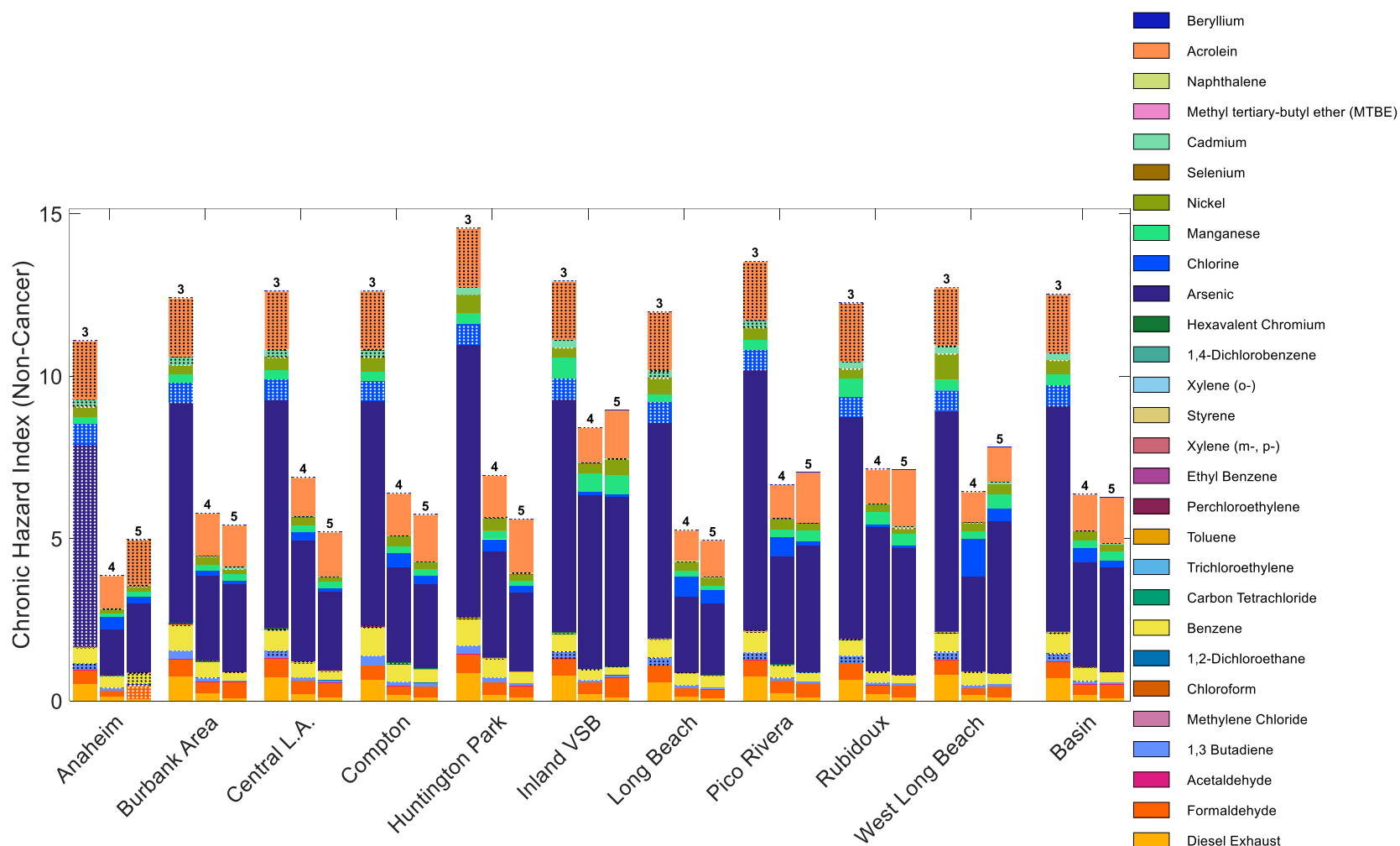


Figure 0-53. Chronic risk trends across MATES III through MATES V at all stations. 1,2 Dibromoethane is excluded because of high uncertainty due to all measurements being below the detection limit for each station for all MATES projects. Bromomethane was also excluded because it was only measured in MATES V and trends cannot be inferred. Gray dots are used to mark bar segments that are more uncertain due to either substitution for data that were unavailable or data for which more than 80% of measurements were below detection limit.

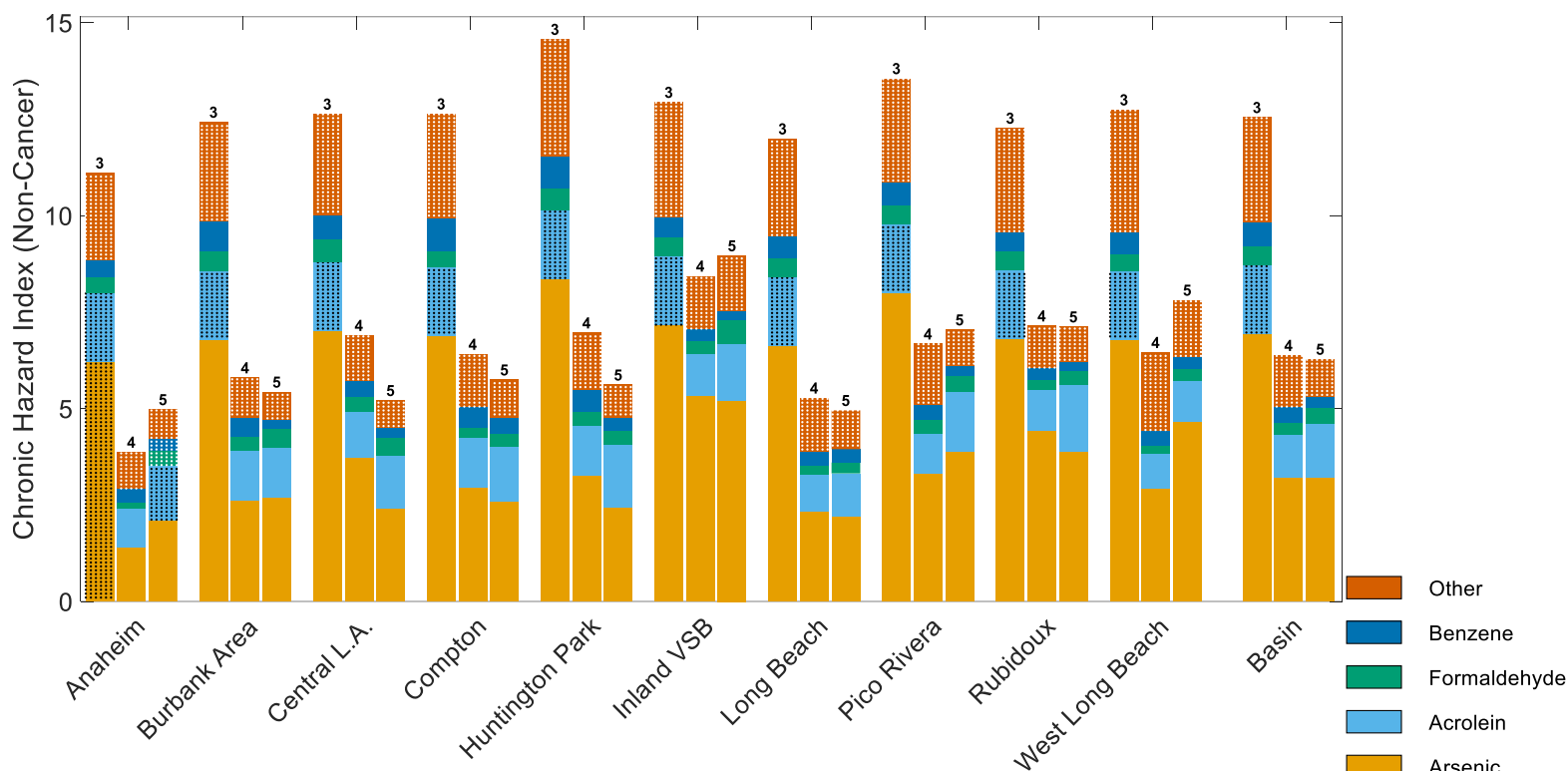


Figure 0-54. Chronic risk trends across MATES III through MATES V at all stations with analytes grouped. 1,2

Dibromoethane is excluded because of high uncertainty due to all measurements being below the detection limit for each station for all MATES projects. Bromomethane was also excluded because it was only measured in MATES V and trends cannot be inferred. Gray dots are used to mark bar segments that are more uncertain due to either substitution for data that were unavailable or data for which more than 80% of measurements were below detection limit.

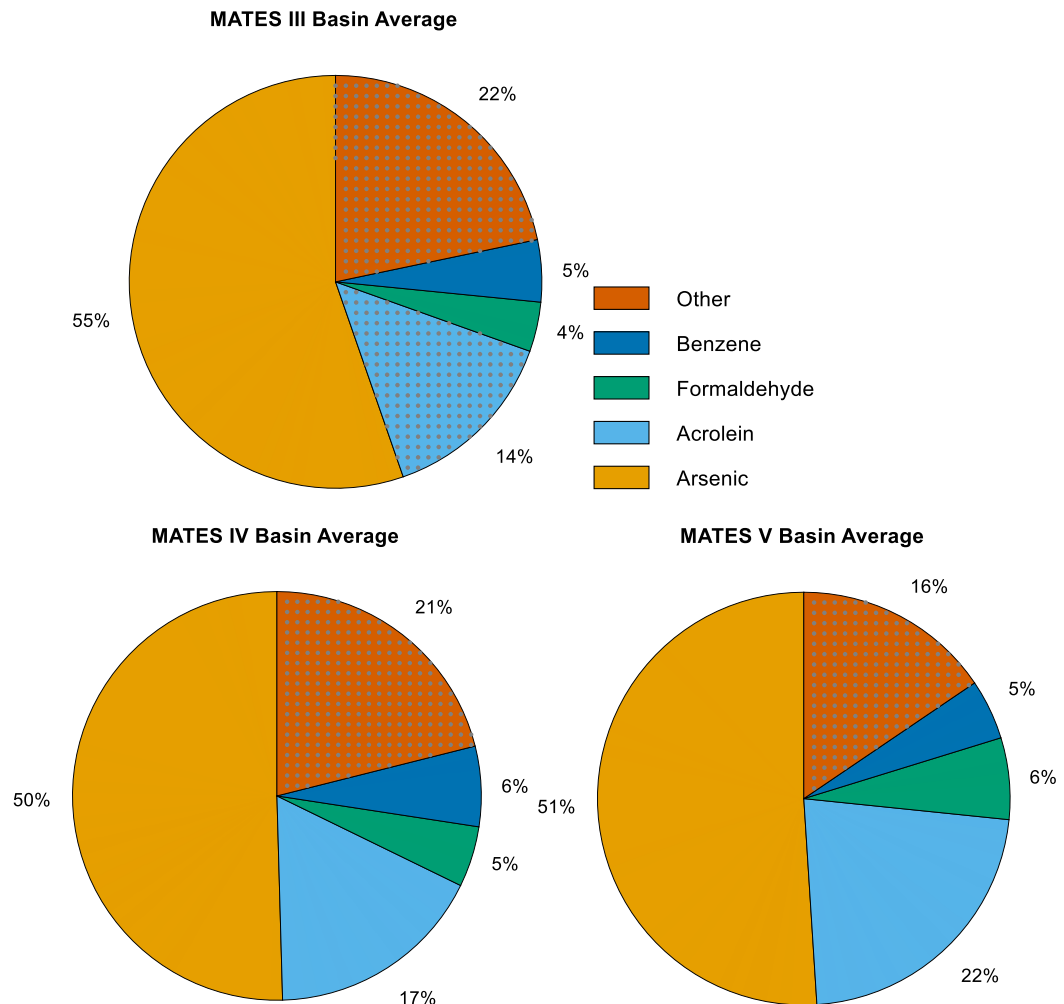


Figure 0-55. Pie charts of the basin-wide cumulative chronic risks for MATES III through MATES V. 1,2 Dibromoethane is excluded because of high uncertainty due to all measurements being below the detection limit for each station for all MATES projects. Bromomethane was also excluded because it was only measured in MATES V and trends cannot be inferred. Note that the MATES V pie chart in this figure is slightly different from the MATES V Pie Chart shown in Figure 0-52 due to the exclusion of Bromomethane from this figure. Gray dots are used to mark bar segments that are more uncertain due to either substitution for data that were unavailable or data for which more than 80% of measurements were below detection limit.